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THE

TRUE ORDER OF STUDIES.

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BY

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Formerly President of Harvard University, author of "Geometry and Faith," Etc., Etc.

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PREFACE.

THE hierarchy of sciences adopted as the basis of this work, was first perceived by me one night about the first of February, 1843, while attempting to answer a chance question. Four years afterwards I began to use it as the basis of lectures on a revised scheme of Common School Education, nearly identical with that presented in this volume. In May, 1853, the hierarchy was first published in an address delivered before the Harvard Natural History Society. I used it in a P. B. K. address at Cambridge, in 1859; and have, since that time, used it repeatedly in addresses, lectures, and magazine articles, and especially in a series of four communications to Barnard's Journal of Education for 1859, bearing the same title as this book.

PORTLAND, Me. August, 1875.

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THE

TRUE ORDER OF STUDIES.

CHAPTER I.

THE CHILD.

A THOROUGH and complete education ought to preserve and increase the pupil's bodily health and strength; give him command of his own muscular, and mental powers; increase his quickness in perceiving through his five senses, and quicken his mental perception; form in him the habit of prompt and accurate judgment; lead to delicacy and depth in every right feeling; and make him inflexible in his conscientious and steadfast devotion to all his duties. In other words an integral education must include at least these four branches :—gymnastics, or care of the body; noetics, or training of the mind; aesthetics, or cultivation of the tastes; and ethics, which shall include religion as well as duty. And in every part of each branch of education, there will be a double end in view, namely, the increase of knowledge, and the increase of skill. Each study may be made the object of

thought, or the object of action; in the one case it is pursued as a science; in the other case as an art.

In the present little book, I occupy myself chiefly with the second branch, the education of the intellectual powers; not, by any means, because I consider it as more important than the others; but simply because I have something to say upon it.

The intellectual powers may be roughly, but conveniently divided into three groups, the perceptive, the imaginative, and the reflective.

By perception I mean the direct vision of truth, whether by outward or by inward sense. By the five senses we have a direct perception of the presence of colors, sounds, odors, flavors, variations of temperature, and other tangible and visible things. By the internal powers of consciousness we have a direct perception of our own feelings, and know that we love, hate fear, are glad or sad; and by internal sense we also know the existence of space, time, power, thought.

By imagination I mean the reproduction, or imitation, in the mind, of the impressions previously made by direct perception. When imagination is confined to a simple reproduction of the impressions made in perception, it is usually called memory; and the term imagination is by most persons confined to the cases in which the remembered impression is variously modified, or merely imitated. The word fancy is by many writers applied to the cases in which the imagination is occupied with inventing imitations of external things, and the word imagination confined to inventions of character or of spiritual attributes.

By reflection I mean the act of comparing, by help of the imagination, the truths of perception, or the creations of the imagination. When this comparison of truths elicits new truths of relation, between the compared truths, it is called reasoning. Thus reasoning may be considered as an art of bringing truths into a position to be perceived by the internal sight.

It may be observed that the words imagination, reason, and perception, are also used to denote the faculties of the mind by which we perform the acts of imagination, reasoning, and perception.

The first act of the mind must always be the direct perception, of some truth, as the necessary prelude to any act of reason or imagination. In the history of any child's intellectual development it is always the case, also, that his powers of external perception give the earliest evidence of activity. For the first seven years of his life, his chief intellectual occupation is the reception of impressions from the senses; and by the age of fourteen years the powers of seeing, hearing, tasting, smelling, and feeling are in their fullest perfection.

The power of imagination does not betray any activity until the child is more than a year old, and it is later in attaining its full vigor, which it seldom reaches before the age of twenty-one. The reasoning power lies half dormant still later than the imagination; and seldom shows activity till after the seventh year; nor develops its full strength until after the twenty-first. The will comes to its maturity of power, with the development of reason.

Nature thus indicates that a teacher in educating a child, should give his earliest attention to the development of the child's perceptive powers. Moreover, among these powers, those of external sense should be the first to receive a careful training, such as is given in the admirable Kindergarten system of Froebel. Afterwards, when the child has learned to perceive with every sense, the imagination must be systematically cultivated. In learning to observe, he will learn to remember what he has observed, and this is an incidental culture of the imagination ; but he must also be regularly trained to invention. This is admirably done by some of the Kindergarten gifts ; and I the more cordially express my approbation of the treatment of the child by Froebel's system, because I disagree so totally with him, in some of the considerations by which he would explain and justify his treatment.

Nature further indicates that a child should not be expected, or required to reason at an early age. Any direct training of the logical powers, before the age of twelve years, is premature ; and, in most cases, a positive injury to the scholar. The common sense view would give facts before reasoning. Reasoning upon the facts is the work of a maturer mind. The play of the imagination should from the beginning be compared with or contrasted with facts ; and, in the later stages of education be carefully guided by reason and conscience.

CHAPTER II.

THE HIERARCHY OF SCIENCES.

IT is evident that we cannot teach a given subject to a child, before he is old enough to comprehend it, nor before he has acquired the necessary preliminary knowledge. In order to learn a given thing, he must be sufficiently mature, and sufficiently well informed. It would, for example, be folly to attempt to teach a boy of six years how to measure heights and distances, by a theodolite and steel tape ; or to teach a boy of any age, who was ignorant of the four simple rules in arithmetic.

It is the object of the present chapter to inquire whether there is any comprehensive order, embracing all the objects of human knowledge, which can serve as a guide in the selection and sequence of studies ; that is, which will help us in deciding what are the proper preliminary studies requisite for the pursuit of any branch, or in deciding which of two given studies ought to be placed first in the curriculum of a school. If the discussion should appear, to any reader, dry and abstract, he may be assured it will be brief ; and that the subsequent chapters shall be occupied with more practical and easily intelligible details.

In attempting to analyze and classify the great

field of human knowledge, we obtain, at first, a separation into four elements, viz. Space and Time, Matter and Spirit. There is nothing, existent or non-existent possible or impossible, which we do not include in some sense, under one of these four heads; while, on the other hand, there is no one of these four which we can clearly bring under another. It is true that we might, in some phases of mind, be tempted to consider Time as a mere abstract notion, formed from our perception of the permanence of Space; it is true that some men have suspected, from the marvellous diversity of the powers of matter, that thought is but a mode of motion; it is also true that the obedience of Matter to Spirit leads a majority of men to believe that Matter is a creation of Spirit; but these opinions are not scientific certainties, like the existence of the four elements.

Of these four, Space and Time are the earliest objects of distinct intellectual action. The attention is called to them by the phenomena of motion and the shapes of material things. The forms, and motions of things, are the food of much thought, and the objects of lively attention and intellectual action, years before the other myriad problems of matter begin to suggest themselves; still longer before spiritual character and the nature of the mental processes, receive any attention. It is true that, to a certain degree, all these elements enter into some of the earliest states of consciousness; so that it might be thought that the knowledge of them is gained simultaneously. But they are evolved out of the mist of the child's consciousness,

one by one ; and become the themes of distinct mental efforts, in the order in which I have named them. The child's knowledge and recognition of things by their shapes long precedes any definite recognition of time or rhythm ; and becomes varied and exact to a marvellous degree, while as yet there has been no distinct introversion of consciousness, and no distinctly intellectual appreciation of character.

Whether Spirit created Matter, as is generally believed, or not, this at least is certain ; that the advancing science of our century tends rapidly towards proving that our only knowledge of Matter is gained through its being the realization of thought, in Space and Time. Sound, color, temperature, and other sensible properties of Matter, are revelations to us of modes of motion in the bodies about us. It is probable that without motion there could not be any sensation ; certainly the human imagination tries in vain to imagine the communication of sensation without motion. But all the motions thus revealed to us, through our sensations, prove on examination to be rhythmical in time, and symmetrical in space. The body which by its motion reveals its existence to our senses, is moving by intelligible law ; it is moving in consonance with a geometrical and algebraical thought. Thus the sensible properties of matter, through which alone the existence of matter is revealed to us, reveal to us directly the existence of thought, anterior to the present state of matter, ruling and guiding all the present manifestations of matter. Thus the being of God is manifest through the existence of the world ; and the

world can be apprehended by our intellect, even in its simple sensible properties, only because those properties are the work of intellect. And this creates a strong *a priori* probability that matter is an absolute creation ; not a fashioning of original material.

We awake to consciousness, through the fact of motion, which reveals to us an outer world, and a universe of Space and Time, in which that world of matter moves. These space and time relations are the earliest objects of distinctly conscious intellection ; the first objects concerning which our knowledge takes a scientific form. This was true of the race, and it is true of the individual. Before the child has a clearly intellectual life on any other subjects, it attains a very definite power to distinguish the square, the circle, the oval, the spiral ; to recognize, by approximate likeness of outline, even rude drawings of men, dogs, horses, cats, cows, trees, and various articles of furniture ;— and also to recognize the rhythm of verse and music.

Out of space and time (which have by some writers been classed, erroneously as I think, among abstract notions, as though mere abstract ideas of extension and duration) arise, through the suggestions of the material world, three principal sciences :—Geometry, Arithmetic, and Algebra. Geometry deals purely with space, and considers it as divided, and portions of it as bounded, by surfaces ; the surfaces divided and bounded by lines ; the lines by points. Space being in itself indivisible, except in imagination, we are led to that act by the perception that matter is not amorphous ; in other words, we are led to imitate the act of

the Divine Intellect, which has geometrized from eternity. No thoughts enter, indeed, the human mind, except at the suggestion, reverently followed, or wickedly perverted, of nature. The forms of material things, conforming to the Divine Geometry, suggest to us the study of pure forms in space, and thus lead us to create human Geometry, the earliest and simplest of all possible sciences.

But the earliest abstraction from the idea of form is that of number; and out of this idea is evolved the earliest of the truly abstract sciences, namely Arithmetic; which thus becomes the second branch in the hierarchy.

The earliest suggestions of motion reveal to us time as well as space; and although these two elements are indissolubly joined in every phenomenon of external nature, they cannot by any exertion of our intellect be made to appear to have any property in common. Space is external to the mind; time enters into our spiritual consciousness, and measures our flow of thought. Space stands immovable, and we can move our bodies through it, or transfer our attention from place to place in it, at our own will. Time sweeps past us with irresistible flow; and it is with the greatest difficulty that we can arrest our attention, even for a few moments, upon an absolutely instantaneous epoch, a point in time. Rhythmical motion connects, however, the abstract idea of number as readily with time as with space; and time, in its turn, gives flexibility to the idea of number, connecting it more intimately with continuous quantity; from which con-

nection springs the third science ; that of pure Algebra. Out of these three, by combination and development, have sprung the wonderful forms of the Calculus, which have shed such lustre upon the 17th and 19th centuries.

The physical properties of matter, which thus suggested to man his earliest systematic study of space and time, next call his attention to matter itself, and the laws under which it moves. From the study of motion, recognized as such, was developed the science of mechanics, following long after the mathematics, but being developed with greater rapidity after it had sprung into life. Parts of this general science, such as acoustics, and optics, were not recognized at first in their true relation to motion, and held therefore, for a time, an apparently independent existence. Certain of the phenomena of the world, which modern science declares must be expressions of particular modes of motion, suggest, however, the idea that matter exists in different original forms. It combines, and separates, into apparently new substances ; and the laws by which it thus apparently multiplies, or divides, constitute chemistry. Other phenomena in nature lead us to separate certain bodies into a class by themselves and call them living. They are to all appearance, not under the strict laws of mechanics and chemistry, but rather use those laws to attain their individual ends; each growing into an individual form of specific likeness ; growing, not by a mere mechanical aggregation of particles, nor simply by a chemical separation of kindred particles, but growing by a compound pro-

cess of chemical analysis and synthesis, and mechanical building according to a complicated intellectual plan. The study of matter in this third, most exalted stage of its action is Physiology ; which completes the division of Physics ; constituted of the three sciences, Mechanics, Chemistry, and Physiology, which manifestly stand related to each other in the order in which I have named them.

Geometry is necessarily the first study, Arithmetic the second, Algebra the third ; as I have defined these studies, they must be understood, in some degree before it is possible to understand anything further ; and the three physical branches, mechanics, chemistry, and physiology must follow in that order. Many persons may be unconscious of possessing any knowledge of either of these sciences, except arithmetic ; simply because their knowledge has not been acquired from text books, and is not arranged in their minds in a systematic or scientific order. Nevertheless, any skilful questioner could draw out of them, a confession of acquaintance with fundamental facts in each one of these six branches ; and thus convince them that they had learned, at first hand, perhaps, from nature, many valuable truths concerning relations of space, time, and number ; mechanical force, chemical changes, such as combustion, oxidation, fermentation, and decay ; and physiological truths, concerning the growth of plants and animals, their food, poisons, sleep and rest ; and these have been acquired in their due order ; the knowledge of each requiring some previous knowledge in the preliminary branches.

The more extensive physical sciences such as geography, or astronomy may be considered as built up of the simpler, in much the same manner as the wider mathematical studies are a combination of the three elements of geometry, arithmetic and algebra.

After acquiring some knowledge of material things, the pupil naturally turns his mind towards an investigation of the uses to which man has put this world in which he has been placed. The attention is first caught by tools and machines, fabrics for clothing, houses, and other external things; by the mastery, one might say, of man over the material world and its subjection to the uses of the human body. Next in order the child observes the manner in which man uses matter as a natural vehicle for the expression of his thought and feeling, as in statues, paintings and music. After this he begins to give consciously his attention to the wonderful manner in which men express thoughts, by conventional modes; which may originally have been but abbreviations of more natural expressions, but have now become, like the clicking of Morse's telegraph, merely conventional modes of expressing propositions of the intellect or emotions of the heart. Finally, among the actions of men, he recognizes the crowning greatness of statesmanship, of the formation of States, and constitutions, the establishment of government and laws. These studies I call in a large sense of the word, historical; and consider them as coming under four heads, for which there are no thoroughly satisfactory names. The first head embraces manufactures, commerce and agricul-

ture, with all their subsidiary mechanic arts. The second embraces the fine arts,—the third deals with language and literature in every form. The fourth embraces jurisprndence, constitutional law, comparative legislation, etc. The larger sciences created by the combination of these heads are Political Economy, Social Statics and Dynamics, and History in its ordinary sense. Thus we have found three great divisions of the hierarchy, the mathematical, the physical and the historical.

But when the child is mature enough so to do, he begins to introvert his attention upon himself, he investigates his own powers, and does for himself, more or less correctly, and more or less thoroughly, what I have attempted to do in the introductory chapter of this book; he analyses and studies the powers of his own soul, and developes for himself an intellectual philosophy, a doctrine of his emotions, and a code of natural ethics.

Nor can he stop here,—he inevitably pushes his thoughts upwards, and enters upon theological speculations. The relation of the Universe to its Creator is a problem that no man of any intellectual development can put aside. Even Herbert Spencer, who has been in our day famous for the strength with which he has maintained that we can assign to the First Cause of the Universe no attributes whatever, asserts with equal strength and emphasis that the existence of that First Cause is forced constantly on our attention, and avouched to us with a certainty that is attained by no other truth whatever. He deprecates theological

discussion but, nevertheless regards himself as taking the most preëminently religious view of the origin of things; and of course can defend this claim only by theological argument. I shall, therefore, continue to count Theology as the head of the Hierarchy of Sciences.

The fivefold division at which we have thus arrived may be set forth in several other modes. The mode in which it first presented itself to me was this; God is the uncreated Creator; He has made us in His own image, as inferior, created creators; we have made many uses of this world, and enacted quite a history upon it; the world itself is deserving of our study, independent of its uses to us; and we find it can exist, and manifest itself to us, only as it floats in space and endures in time. This gives the hierarchy in its descending order; but in education we need its guidance in the ascending order. In that order it agrees with the expanding powers of the child's mind and with the logical sequence and dependence of thoughts.

We can form dim conceptions of the spiritual attributes of the Deity, only in proportion as we understand our own faculties, in which lies our likeness to Him; we can understand the human faculties and human nature only as we observe and study the words and deeds, the achievements of men; we can understand the achievements of man only as we have a knowledge of the theatre wherein he has wrought, and the material he has had to work upon; and we can understand this heaven and earth, only

in proportion to the clearness and profundity of our knowledge of the laws of space and time in which they exist.

In every school, therefore, and in every private tuition of a child, the question must constantly be asked, not only whether the child is old enough to learn what you are attempting to teach him, but whether he has the requisite knowledge of the preliminary branches. There is no single fact, or doctrine, in Theology or in Psychology, which does not require from the pupil, some definite preparation in historical, physical and even mathematical studies. What that preparation ought to be, is an important question ; and, in seeking an answer, the Hierarchy of Science is a valuable guide. The scheme, carried more into detail, will be found in the following table.

SCIENCE,

Has been, or may be, divided into five departments,

THEOLOGY,	The Infinite Spirit, the Unlimited Will;	**Religion,** / **Natural Theology,**
PSYCHOLOGY,	The Finite Spirit, the Limited Will;	**Ethics,** / **Æsthetics,** / **Mental Philosophy.**
HISTORY,	The Acts of Man, the Creations of the Finite Will;	**Law,** / **Language,** / **Art,** / **Trades**
NATURAL HISTORY,	The Material World, the Creations of the Infinite Will;	**Biology,** / **Chemistry,** / **Mechanics,**
MATHEMATICS,	or, The Field of Time and Space in which Creation is wrought;	**Algebra,** / **Arithmetic,** / **Geometry,**

Investigating the Laws of Existence or Modes of Manifestation of

And these departments have been, or may be, divided into the Branches

Treating of the more Special Fields of

The Relations of God to the Human Soul and to Finite Spirits,	Investigation of particular Fields of Religious Inquiry,	Evidences of Christianity,
		Dogmatic Theology,
His Relations to the World and to History.	Investigation of particular Fields in Natural Theology,	
- - - - - - - - -	- - - - - - - - - -	- - - - - - -
The Will and the Ideas of Duty, &c.,	Discussions of particular Relations in an Ethical Light,	
The Emotions and Ideas of Beauty, &c.,	Analysis of particular Classes of Emotions,	Theory of Education,
The Mind and Ideas of Truth, &c.,	Metaphysics, Logic,	
- - - - - - - - -	- - - - - - - - - -	- - - - - - -
The Attempts of Man to enforce his Ideas on his Fellows.	Law of Nations, Constitutional Law. Jurisprudence,	History,
The Use of Symbols to express Ideas.	Philology, Rhetoric, Poetry,	
The Material World as naturally expressive of Thought and Feeling.	Music, Painting, Sculpture, Architecture,	Social Science,
The Material World in Material Uses.	Commerce, Manufactures, Agriculture,	Political Economy,
- - - - - - - - -	- - - - - - - - - -	- - - - - - -
Plants and Animals, or Matter as living.	Zoology, Botany, Physiology, Organic Chemistry,	Geology,
Matter as distinguished into Kinds.	Inorganic Chemistry, Electrics, Thermotics,	Geography,
Matter as the subject of Motions.	Optics, Acoustics, Dynamics, Statics,	Astronomy,
- - - - - - - - -	- - - - - - - - - -	- - - - - - -
The Ideas of Time or Progression.	Theory of Functions, Theory of Equations,	Kinematics,
Number and Ratio.	Theory of Probabilities, Theory of Numbers,	The Calculus,
Space, Distance, and Direction.	Analytical Geometry, Trigonometry, Descriptive Geometry, Plane and Solid Geometry	Quaternions, Stigmatics.

The branches, by Decomposition and Partial Recomposition, give rise to Special Branches, such as

Or to the more extensive Branches, such as

CHAPTER III.

MATHEMATICS.—GEOMETRY.

WE have endeavored, in the preceding chapter, to show, that all possible objects of human thought are comprised under one or another of these five heads: Mathematics, Physics, History, Psychology and Theology. In making these the objects of study, mathematics must precede physics, because conceptions of form, time and number must precede conceptions of material phenomena. For example, mechanics treats of motion, in straight or curved lines, of the parallelogram of forces, and direction of reflected and refracted motion, of the strength of materials as dependent on form, of the equilibrium of the arch; and in these and other problems, demands a preliminary knowledge of geometry. Chemistry deals with definite proportions, atomic weights, permutations of combinations, multiples in series, and other matters, necessarily involving a preliminary knowledge of arithmetic. Botany and zoology in their morphology require geometry; in their physiology, chemistry; in both departments, mechanics.

As mathematics thus necessarily precede physics, so physics must precede history. All that men do in

this world, must be done upon the materials set before us, and under the conditions imposed by physical laws. Our thoughts can find expression only through outward symbols, in things built or made, in imitative arts, or in language; which, when verbal, was all originally figurative, and when musical, is subject to laws of rhythm and elasticity. The history of human thought must also include, as one of its most important chapters, the history of the physical sciences, and thus demand some knowledge of those sciences.

Moreover, Psychology can be advantageously studied, only by one acquainted to some extent with physiology, and with history. We know nothing of the powers of the soul, except as we manifest them, or see them manifested by others; and in judging of the soul from our external action as interpreted by consciousness, we must also learn what allowance to make for the automatic action, under physiological laws, of the body in which we dwell.

Lastly, we have endeavored to show that Theology requires a knowledge of all the inferior branches. We can know, by nature, nothing concerning the Creator, in whose image we were made, except by studying his works, and especially by studying that image of Himself which He has placed within us. We may have religion with very little theology; but we cannot have any theology at all without some previous knowledge of the lower branches, and especially of psychology.

Thus it is evident that the mathematics take logical precedence, as the great and indispensable foun-

dation of all learning. It is not only impossible to dispense with them, but impossible to place them anywhere else than at the beginning of all intellectual education. All intellectual life upon our planet begins with geometry; it was so with the race; it is so with the individual. A man's geometrical knowledge may have been learned unconsciously, as M. Jourdain's prose; but it is no less a real knowledge of space and form, and no less the real foundation for all the other knowledge he possesses; first, for his knowledge of number, of rhythm, of time; then for his knowledge of business, morals, politics, and religion.

A natural method of education requires us, therefore, to pay our earliest attention to the development of the child's power to grasp the truths of space and time, his mathematical power,

The three great branches of the mathematics are Geometry, Arithmetic and Algebra. If the reason for arranging them in this particular order is not clearly apparent, on a consideration of the sciences themselves, it may become clearer on considering the sequence in the development of the child's power of thought. Number, although an abstraction very early made from the contemplation of forms in space is manifestly subsequent to the perception of the forms themselves. The child recognizes hundreds of objects from their shapes long before he could be taught to count them; therefore, geometry precedes arithmetic in education. Again, time is much more difficult to see, than space; it requires a riper effort of the imagination to separate time from the succession

of events, than to separate space from the extension of bodies. Space remains, so to speak, visible, to the mental eye; but time cannot, by any device of the imagination, be made to appeal to sense. Algebra, therefore, the science of time, follows arithmetic, as arithmetic follows geometry. Every day, from the hour of birth, a new knowledge of forms developes new power in numbers; and that again, new power in the consideration of flowing or changing quantity; and thus the child runs its round; from geometry to Theology, and then to a higher point in geometry, and round again to Theology; in ever recurring five-fold cycles, as long as it continues its intellectual development and growth.

Until the age of four or five years, the child is seldom at school, and seldom directed at all with a view to intellectual education. The best parents, usually, content themselves with looking after its physical health, and its habits of obedience and order in the house. Nevertheless the education of the first years of life is, in many respects, more important than any which follows. There can be no doubt that early impressions are very deep, and exert great power over the subsequent life, physical, intellectual and moral. Every observer knows the difficulty of correcting the moral habits of a spoiled child. The difficulty of correcting his intellectual habits, although less apparent, is as real. For this reason, I have endeavored to persuade the school committees with which I have been connected, to secure the highest talent and pay the highest wages in the schools for

the youngest pupils; convinced that this would in the end, most truly elevate the character of the whole community.

For the geometrical education of children under five years of age, the early kindergarten gifts are admirably adapted. Picture books, provided the drawing is good, are also valuable; and many of the toys given to children serve a good purpose in this direction.

We must, however, remember that the great ends to secure, by early geometrical culture, are accuracy of observation, and definiteness of imagination. These uses of geometry have been strangely neglected by both friends and foes of this intellectual gymnastic. The admirers of geometry have contended themselves with showing that no other study holds the student to such continuity of thought, to such extended series of consecutive, dependent arguments. And in Sir William Hamilton's plea against the use of geometry in education, he contents himself with showing, as he thinks, that other sciences afford better training for the powers of logical thought.

But the powers of perception, and the powers of imagination, or conception, are of even greater importance than those of reasoning; they give us the facts of nature, and definite theorems in science, without which reasoning is vague and worthless. The early studies of the child, therefore, while seeking to develope his ideas of space, and time, must do so by training him to rapid and exact observation, clear and definite conception.

Miss Edgeworth, in one of her invaluable stories, describes small wooden bricks ; rectangular parallelopipeds, whose dimensions are in the ratio 1 : 2 : 4. In the public schools of Waltham, we used to supply the scholars, under 10 years old, with such bricks, made of birch or maple, two inches long, one inch wide, half an inch thick ; with a small percentage of double length, and half length. Each scholar, when playing with these bricks in school, had his desk covered with a piece of dark cotton velvet, to prevent noise, and prevent slipping. For younger children before they come to school the bricks may be larger, and of lighter wood. A child of eighteen months old will find amusement in them. The variety of structures, all beautiful and symmetrical, which an ingenious boy, of ten years, will make with a few dozen of such bricks, would astonish the unitiated. Square and circular buildings, pyramids, crosses, gateways, columns surmounted by crosses, and natural arches of various forms, will be devised by the child, and combined in a variety of modes. For the building of real arches, centerings must be provided, and also a substitute for mortar in the shape of numerous little sticks, like Vienna matches without phosphorus, one to be inserted in each joint of the arch, before the centring is removed. This process, as well as the breaking of joints, binding of crosses together, erecting of the long cross-bar in crosses, etc., will give incidental instruction in mechanics, as well as in geometry. It will also give valuable lessons on the importance of precision, and promptness in action and observation.

The Chinese tangram consists of seven pieces of flat metal or wood :—five isosceles right triangles, a rhomboid and a square. The area of the seven pieces being called unity, the areas of the square, the rhomboid, and one of the triangles, are each one-eighth ; two of the remaining triangles one-sixteenth each ; and the other two one-quarter each. They are accompanied by a book containing hundreds of oddly shaped rectilinear figures ; any one of which may be made by putting all the seven pieces together. Learning that Archimedes had invented a similar game, and ascribed to it an educational value ; but feeling that the Chinese tangram was too difficult for beginners, I published in 1848 a much simpler form and introduced it into the schools of Waltham, where it was used for many years. Two hundred and four figures were given, each capable of analysis into three isosceles right triangles ; and the area of these triangles were either the ratio 1 : 1 or 1 : 2. These "puzzles to teach geometry," cultivate the habit of exact observation, and of the rapid analysis of forms. They may also be made of curvilinear figures. I have frequently used, instead of triangles, trigonoid figures, each being enclosed in three arcs, one of 120°, and two of 60°. Two varieties of the trigonoid are procured by having, in some, both arcs of 60° concave, in other only one.

At the earliest stage of schooling the child may be taught also to derive instruction from his slate and pencil. Agassiz is reported to have said, in regard to observation in Natural History, that a lead pencil is a

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very good microscope ; and the slate pencil serves the same purpose for the younger pupil, in the more fundamental study, of geometrical forms. When the child can use the pencil, he can also use the crayon upon the blackboard ; and the ingenuity and skill of men in Waltham, have brought white crayons of the best quality within the reach of every school. As a suggestion of the mode in which the pencil and crayon may be made to conduce, rapidly, to accuracy and quickness in the perception of geometric form, take the following exercise.

Let the teacher have cards or tablets each containing one clearly drawn simple figure. For younger classes these figures may be ; a horizontal straight line, a vertical line, a line slanting to the right, a line slanting to the left, a St. George's cross, a St. Andrew's cross, an arrow head, an arc in one position or another, etc. For classes a little older the figures may be triangles in different forms and positions, circles, circles with a diameter in different positions, ellipses of different forms and positions, capital letters, etc. Classes still more advanced may take lower case letters, Roman and Italic, outlines of forest leaves, profiles, outlines of familiar animals, utensils, etc., Gothic arches, numerals, etc. These cards, or tablets may be permanently printed, or they may be made extempore by the teacher, a slate with a crayon drawing will answer every purpose, in the hands of a teacher who can draw rapidly and correctly. The class being ready with their slates, or at the blackboard, the teacher calls their attention, and ex-

poses her card for a few seconds, longer to absolute beginners in the exercise, but afterwards for still shorter times, until it is reduced to a minimum exposure. Then each pupil draws immediately from memory a reproduction of what was shown, and exhibits it for criticism. This will be found an admirable preparation for subsequent observation of objects of natural history.

When the child is able to analyze figures composed of three or four triangles; and to copy triangles and rectangles with approximate similarity to his copy, he will be ready for conversations upon geometrical theorems. The steady aim of the teacher in these conversations must be to lead the child to see for himself; not to learn words by rote; much less to learn reasons for belief; but to see the truth, directly, without the intervention of reasoning, and without appeal to reasoning for verification. Whatever proposition you announce to him, announce to him as known, and to be received by him, for the present, simply as food for his imagination; do not attempt, nor lead him to attempt to prove it, nor to use it as proof; that exercise of logic belongs to a later period in his course. If the child asks for proof, and the demonstration is fully within the grasp of his mind, it may do no harm to give it;—but it will be an exceptional case; there are very few children under twelve years of age, capable of understanding the simplest geometrical demonstration. On the other hand I have seen scores of children in the primary schools of Waltham, under ten years of age, who by familiar oral instruction on the

part of the teacher, had been made well acquainted with the leading truths of the geometry of the triangle and the circle; many also under twelve years, who had in like manner attained a clear knowledge of the relations of the cycloidal curves, and their evolutes; and of many theorems concerning the conic sections and the catenary curve.

The ease of imparting such information, or leading the child's imagination into such exercises is greater than the teacher who has not tried it would imagine. Take any clear-headed boy of ten or twelve, and suppose to him the case of a goat on a plain, tethered to a ring, sliding on a cord, fastened at either end to one of two stakes, whose distance apart is less than the length of the cord. Question him about the goat's liberty of movement, and you will very readily lead him, by questions only, to see that the ring is confined to an oval, which is symmetrical on two rectangular axes (he of course will not use these technical phrases of words but he will describe the facts), the longer diameter passing through the stakes, and that the sum of the distances from any point in the periphery to the two stakes will be constant, and equal to the longest diameter. Then imagine a dove for the goat, a finger ring and thread tied to the tops of two tall poles and you can lead him to discern the form and some of the properties of the prolate ellipsoid.

Now if it be asked of what value are these geometrical conceptions to the scholars who have thus early attained to them, I answer that the uses of the knowledge will be manifold. It has already afforded

to each of them an excellent culture in the power of clear and definite conception ; it has enlarged their sphere of thought, and linked the higher mathematical truths with their playthings,—the hoop, the swing, the jumping rope, the ball, and its movements ; it has made them partakers in the fruit gathered by the highest spirits of our race.

The clearness and precision of observation and imagination, cultivated by these early geometrical studies, will be of use in every occupation of life ; and render the student's testimony and his judgment of more value in after life, both to himself and to other men. Even the powers of the eye and of the hand will be more likely to be cultivated with care, for uses of industrial art, by one whose imagination has been thus developed and strengthened. And if there chance to be, among the children thus early imbued with the germs of geometry, any scholar whose natural gifts peculiarly fit him to advance its progress, or to use the higher mathematics to advantage, nothing could more surely lead him to application, and improvement of his gifts, than to set before him at an early age some of the curious and interesting results that have been attained by the labor of his predecessors. As the visible forms of nature stimulate the imagination, so the creations of the imagination stimulate the reason.

The sight of a hanging chain, for example, may stimulate the imagination to conceive of a chain formed of infinitesimal links, producing a uniform curve. This conception arouses the logical powers to

inquire into the relations of the parts of such curve to each other, and to the forces which hold it in equilibrium. A boy of ten years old playing with such a chain, may readily learn some of the truths which such inquiries bring to light. He may roughly test by his muscular exertion, or more accurately test by a little mechanical ingenuity and measurement, the truth of your assertion, that the length of a piece, of the same chain, equal in weight to the horizontal tension, will strike, used as radius, a circle just large enough to fit exactly the lower part of the chain ; and may easily be led to draw the corollary that no amount of power can draw a horizontal flexible thread perfectly straight. The marvellousness of this corollary will fix the theories ineradicably in his memory, and he will, years afterward, when he begins to learn how to demonstrate the theories of geometry, wish to prove the proposition. But he finds that simple geometry is not enough. He takes up algebra, learns to apply it to geometry ; but the problem is still too difficult for him ; he adds the resources of trigonometry, but is no nearer the proof that he desires. He enters college, learns the marvellous uses of Descartes' coördinates ; but finds his chain still hangs beyond the reach of their magic. Nor is his curiosity, aroused at so early an age, gratified until, perhaps in his senior year, having learned something of the wonderful calculus of Leibnitz and Newton, something of the analytical mechanics of Lagrange, he takes up the discussion of the catenary curve.

The student who has in childhood become familiar

with the facts of geometry, approaches, when nearer manhood, higher mathematical studies under less disadvantage than others. The student who betakes himself, as preparatory to higher engineering or architecture, to the study of the conic sections, the arch of equilibrium, and other transcendental curves, has usually a twofold difficulty; he is receiving novel and bewildering ideas, at the very time that he is also learning a new language in which to express them. But if he has already become familiar with the properties of the curve, and easily form a clear picture of it in his imagination, he can give his whole attention and whole strength to the mastery of the language, the analytical key that unlocks the hidden treasure-houses of the Science of Space.

In order to facilitate the formation of habits of precise imagination at the beginning of the course, we introduced into the Waltham Schools, to be used upon the teacher's desk, several pieces of home-made apparatus, for the mechanical production of curves and illustrations of theorems.

When he attains the age of 12 or 13 years, the pupil having learned a little arithmetic also, may begin problems of geometrical construction. I have known boys, at that age, who made quadrants, and horizontal circles for themselves, and solved graphically, problems in heights and distances, and surveying; and who habitually carried in their breast pockets, sundials of their own construction, which by a thread and plumbline, gave them the hour of the day.

A year or so later, the pupil will be mature enough

to comprehend geometrical reasoning. The ordinary text-books on geometry fail, as I think, in their adaptation to children from three circumstances. First, in not explaining the object of reasoning. The child plunges into demonstrations, without having any conception of what demonstration is, or what it proposes to do; and he not unfrequently passes through his whole course of mathematical instruction in a state of bewilderment, never having clearly perceived the force of a Q. E. D. Secondly, the ordinary text-books give their propositions in a disconnected manner, so that it is only by accident that some scholar, brighter than the average, perceives that to attain to some of his propositions in isoperimetry he must weave a connected series of two or three hundred propositions, not one of which can be omitted, or transposed, without destroying the validity of the whole argument. Thus geometry loses much of the very excellence for which it is commonly extolled, the teaching of a patient continuity of attention, of a close adherence to the logical sequence of thought. Thirdly, the usual treatises confine themselves to the demonstration of theorems and solution of problems; — giving no exercises to be solved by the pupil, as in arithmetic and algebra, and in various arts of mensuration. In my "Second Book in Geometry" I endeavored to remedy these three defects, by explaining carefully, in preliminary chapters, the object of demonstration; by giving demonstrations of only two theorems, but selecting such as required the demonstration of about two hundred preliminary propositions; and by ap-

pending unsolved theorems and problems to some of the chapters. I have been partially followed in the second and third of these reforms, by William F. Bradbury, and hope that other writers on the subject will be led into the same path.

CHAPTER IV

ARITHMETIC.

AT the same time that the child is expanding his powers of geometrical conception,—let us say from the age of five or seven, to that of eleven or twelve, according to his natural ability,—he should also be gaining simple ideas of numbers. Before he enters school he has usually gained, without effort or intention on the part of his parents, sufficient knowledge of shapes and forms, to serve as the basis of a partial knowledge of numbers under five. Let his schooling in arithmetic begin with developing, and making clear, these partial and confused ideas. The order of nature requires that this should be done at first by concrete illustrations; beans, grains of corn marbles, pencils, buttons, blocks, or counters. On the whole beans are, when we wish to illustrate large numbers, the best; being at once cheap and clean.

The method of teaching which has always seemed to me the most natural and effective, is substantially that which has recently been called Grube's method; but which has probably suggested itself, independently, to many thoughtful educators. A number is the answer to the question how many; but the usual

method of teaching a child to count is apt to produce a confusion in its mind between ordinal place and numbers. Counting, or naming numbers in their order, should not be taught until the child has learned to recognize the numbers themselves. Expose successively, in front of a little book or slate, the fore-finger, little finger, ring finger, middle finger ;—asking each time, "How many fingers do I show," and dictating, if the child cannot answer, the answer, one. In like manner, show successively fore and middle, fore and ring, fore and little, middle and ring, middle and little, ring and little ; asking at each exhibition, the same question, and dictating, if the child hesitates, the answer, two. Exhibit in like manner, first one, and then two, beans, pencils, marbles, books, chalk marks, chalk crosses, letters of the alphabet, etc., varying the position and direction of the couples, until you are assured that the child really knows the meaning of the words, two, and one. But do not yet begin to teach him to count, *i. e.*, to say one, two. Expose now three fingers, three beans, three books, etc., etc., in various collocations, until he recognizes a triplet, under any disguise of form ; and to the question how many, always promptly answers three. Review now his knowledge of two, and one ; and when there is no doubt in your mind that he knows one, three, or two, objects of any kind, in any position to be one, three, or two, you add a new element as follows :—

Place a finger of the right hand in front of one little book, of the left hand in front of another ; ask separately concerning each, then bringing the books

and hands together ask of both. Then put the question in concrete form, one finger (showing the right hand), and one finger (bringing up the left) make how many fingers? If the child does not say, at once, two; it shows that he had not learned perfectly the distinction between one and two, and you must begin again with the first exercise. But if he answers promptly, then is your opportunity to put your first abstract question, then one and one make how many? and he will answer, two. You may then ask; And if I take one away from two (suiting the action to the word) it will leave how many?

Many teachers will pursue this method of nature thus far; but its great value can be really appreciated only by one who will follow it carefully up, at least as far as to the number thirty. This will require time and patience,—months and years will elapse,—but the labor will be abundantly rewarded. The process at first should be very slow, and the child should be led, somewhat in the manner I have indicated above, to see for himself that two beans and one bean make three beans; one from three leaves two; two and one make three, two from three leaves one; one and one and one make three. Treat each number successively in the same manner until you have reached six. You may now arrange a series of little parcels of beans, or groups of chalk dots, in order, and lead the child by judicious questions to see that the numbers four and six can be divided into twos, and the number six into threes. You may also ask him to name them in order, and lead him to perceive that

each is formed by adding one to the preceding. Then giving him a handful of beans you may let him drop them one by one in a place by themselves, naming as each one drops, the number which he thus doles out. Proceed now to twelve, slowly and gradually. Great quickness in counting may be produced, without strain on the child's mind, by a process similar to that named under geometry; expose, successively,—for a few seconds to the youngest, for a fraction of a second to the older pupils—three, two, five, six, four, one, five, seven, etc., objects, and see who can, a moment after wards name the number.

By the time that you have reached the number twelve, your division of numbers into classes may begin to receive names. The numbers that can be divided, into couples of beans, without leaving an odd one, are called even numbers; those that leave an odd one, are odd numbers. Even numbers increase by twos, and so do odd numbers. The numbers above twelve being too large to be recognized at sight, may be counted by addition of twos, threes, or fours—and the child will probably find that he has been thus recognizing the numbers between six and twelve, by addition. The commutative principle of arithmetic may be shown by dividing six into three twos, or two threes, still using beans. With the same illustrations, before you have reached the number thirty, you may lead the child to see for himself the difference between prime and composite numbers; the meaning of equal factors; the nature of powers and roots; the value of Eratosthenes' sieve, and its defects; the distinction between

the two factors, that one is abstract and the other concrete, etc., etc.

The little primary arithmetics which the diligence of our writers has produced, endeavoring to substitute pictures for real objects, in giving the first lessons in numbers, are of little value to the pupil, and do much harm to the teachers, by deluding them into an entirely false view of the functions of their office—a view which is hardly caricatured in the jocose anecdote of the teacher who gave a boy, of four years, the three first letters of the alphabet to commit to memory and recite at the next hour,—the boy never yet having heard the names of the mysterious symbols. Text books are the incubus on our New England schools, turning the attention of the teacher and the child away from nature and from truth, to fix it on the errors and weakness of men. Arithmetic is taught backward, beginning with reasoning instead of with observation, and is hampered with factitious difficulties or artificial rules and processes. I have known but three really good treatises on arithmetic published in this country, in my day; one of these, Warren Colburn's First Lessons, has been abused, by being put into the hands of children too early, and has thus been productive of almost as much harm as good; a second was promptly suppressed by legal proceedings, because it infringed on Pliny E. Chase's copyright; and Chase's Arithmetic has gone out of print, and the stereotype plates have been melted, because the popularity of a text book in America is in inverse proportion to its real merits. All other school arithmetics now in the

market have a great similarity to each other; the best differing but slightly from the average.

Very soon after the child has become familiar with the names of the first half dozen numbers, and can instantly name, without conscious counting, any number of beans under six, he should be taught the Arabic figures representing them, and from that time should be taught to write, instantly, the figure representing the number of beans exposed to view. Quickness in writing numbers should now be cultivated by requiring the children, pencil in hand, to write the Arabic figures on the slate, as you successively expose for a second each small number of objects.

Two or three hundred beans may now be arranged in heaps of ten, and those heaps in groups of ten, and the mysteries of decimal notation be thus made clear to sight. The rapidity with which the value of the units in the different places increase as you go to the left will never be distinctly appreciated until the child sees for itself, in the heaps of beans, how few figures are needed to express the largest quantities. When he has perceived this he will comprehend why men need names only as high as millions.

Then break up a few dry beans and select pieces that shall average about one-tenth of a bean each, and some also to represent hundredths, and he will see in the rapid decrease of size, why we so seldom need decimals beyond millionths. Teach him from this point the mode of writing decimal fractions, without any allusion to vulgar fractions. He is now ready for addition, subtraction, multiplication and division, in

both whole numbers and decimal fractions, and can learn them both at once, as easily as he can one of them. For the first two years after he has thus begun to cypher, let your whole aim be to make him expert in performing these four operations. Do not ask him to commit any rules to memory, do not ask him to explain or understand the reasons for his operations, but simply keep him at work on simple examples in numbers, whole and decimal. Avoid even giving him problems that shall require any ingenuity in reducing them to form ;—but give him figures to operate upon, and tell him what to do, until the mere addition, subtraction, multiplication and division of whole numbers, or decimals, and the correct pointing and reading them, shall be an automatic process, like the reading of the easiest story book.

The teacher who has been accustomed to the modern erroneous method of teaching a child to reason out his processes from the beginning may be assured that this method of gaining facility in the operations, before attempting to explain them, is the method of nature ; and that it is not only much pleasanter to the child, but that it will make a better mathematician of him. In this work of cyphering fast, dictation exercises, like Walton's, are of great value. Especial attention should be given to the addition of columns, that being the place in which arithmetical blunders most frequently occur. A convenient method is to give to the class from your extempore invention, any odd number of numbers, each beginning in the same place, keeping a record of them ; for example, 248,

751.6, 842, 943, 851.7: then give the arithmetical complements of all, except one; for example, give all but the second one above, 752, 158, 57, 148.3; and then say, add. The class, not knowing your key, can add the numbers quicker than find the key; you, knowing the key, write the omitted number, 751.6, and prefix to it the number of complements, 4, giving instantly the sum, 4751.6; and you are ready to test at once the accuracy of the swiftest computer. Similar methods are easily devised for the other rules.

There is a difficulty in a child's mind, not usually recognized by the teacher, in passing to the application of number to continuous quantity; and one of the minor advantages of introducing decimal fractions into the very beginning of written arithmetic, consists in its affording a ready means of introducing the idea of an arbitrary or artificial unit. Arrange the number 123.45 for example in this way; First place to the child's left a group of ten heaps, ten beans in a heap: then passing to the right, making another group of two heaps; still further to his right place three beans; then four pieces averaging a tenth of a bean each; and lastly to the right lay five fragments of bean dust for hundredths. Now lead him to see that these 123.45 beans may be written as 1.2345 groups, or as 12.345 heaps, or as 1234.5 tenths of a bean, or as 12345 hundredths of a bean. Repeat this lesson, varying the numbers, day after day, week after week, until the pupil has become perfectly familiar with the conception of varying the unit from groups, to heaps, to beans, and to hundredths. Lead them by

judicious questions and the actual exhibition of coin, to see that $12.375 may in like manner be called 1.2375 eagles, or 123.75 dimes, or 1237.5 cents, or 12375 mills. Next give them a meter stick, and show them its division into ten decimeters; 100 centimeters; and its possible division into 1000 millimeters, and measuring the length of books, tables, window seats, &c., in the school room, show them how each can be expressed in terms of either of these units;—and the passage from the natural to the artificial unit will have been made unconsciously. The process should however be continued further, by learning, from good maps, not otherwise, the distance from the school house of prominent objects in the neighborhood, other schools, churches, banks, hotels, cross-roads, bridges, &c., and requiring the children to express the kilometers as meters, centimeters, and by moving the decimal point. Be careful that the child has a definite conception or image of the length of the metre, and its parts. One mode of doing this is to allow the scholars to estimate the length of various objects, and then test the accuracy of the estimate by applying the meter stick. A little rivalry in this matter is of great benefit in sharpening the powers of observation and judgment.

The passage from linear to square and cubic measure is also accompanied with more difficulty, in a child's, mind, than the teacher is usually aware of. Indeed we seldom find even an adult, except in certain professions, who has a really practical appreciation of the different rates of increase in linear dimensions,

surface, and solidity. To assist the pupil in gaining this appreciation it is well to have a square meter permanently marked upon the blackboard; and also to furnish the school with pieces of card, one decimeter square; and other pieces one centimeter square. Five of the larger pieces of card will thus give the means of making a litre measure in cubic form, which ought to be the first form in which solid measures are introduced to a child's attention.

We are thus particular, and emphatic, concerning the early steps of mathematical education, because it is "the first step which costs." Much more labor is requisite to unlearn than to learn. As we have before said, the younger the class of pupils, the more need of a high moral and intellectual character, and of peculiar aptness for teaching in the teacher. The teachers of the youngest classes ought to deserve and to receive the highest wages.

Fifty years ago the treatises on Arithmetic were blind guides, giving very imperfect announcement of rules, and no explanations. In the modern reaction the opposite extreme has been reached. Explanations, and reasons, and pictured illustrations, have expanded the course of Arithmetics, until the unfortunate pupil is lost in a wilderness of words, and does not find his way through in time to learn to cypher. The science of Arithmetic receives so much attention, that the art is neglected; and the elements of the science are so much expanded that its higher parts are never reached. The primary object in the earlier years, from 7 to 12, should not be to develop

the reasoning power, but to give familiarity with the forms of calculation ;—so that when a child is asked a question, he should not begin a course of analysis and reasoning based upon a model in the text book, or given by the teacher ; but should begin instantly to add, subtract, multiply, divide the numbers themselves and give the answer in numbers instantly. After the age of 12 he may begin to learn to explain, using Warren Colburn's First Lessons. Life is not long enough, to spend so large a proportion of it on Arithmetic as is spent in the modern system of teaching it ; and Arithmetic is too valuable an art, to have our children neglect to acquire facility in it, while they are being stupified, and disgusted with premature attempts to understand it as a science.

The fewer the artificial rules in Arithmetic, the better. Vulgar fractions must always be retained ; and for the next fifty years we shall need English tables of weights and measures ; after that it is to be hoped that they will drop into disuse, as the shillings, ninepences, fourpence-halfpennies, fips and elevenpenny bits of fifty years ago have given place to dollars and cents. Square root and cube root must also be retained ; and it were very desirable to reintroduce into the school books the rule of Double Position, as a natural introduction to the larger methods of modern mathematical science. If, at the same time, four place logarithms could be introduced, a great variety of problems could be solved interesting to the pupil, and stimulating him to a thirst for higher knowledge. Logarithms could be used to advantage

in many operations of business life, where they are now neglected: and would be used, did the pupil learn in the common school how rapidly and easily he attains accurate results by them. For the child's use three place tables might be large enough, and the cost would be trifling. The labor of using tables increases very rapidly with the increase of decimal places; and it is a point of practical wisdom to use tables of a size proportioned to the nature of your work. Six place tables seem the most ill-judged of all; being too unwieldy for ordinary problems, and not nice enough for nicer operations.

CHAPTER V.

ALGEBRA.

ALGEBRA was originally considered an extension of Arithmetic; and its essence was supposed to consist in representing numbers by letters; so that we could represent an unknown number by a letter, and work upon it as if known. This is still the best way of introducing the pupil to this study. And it were well if part of the time saved by reducing Arithmetic to reasonable bounds, were given to acquiring this art. There is no difficulty in teaching the scholars in the Grammar school, as they are finishing their arithmetic, the meaning of the signs, $+$, $-$, $=$, $()$, $()^n$, and the like; nor in teaching them to perform their arithmetical examples not only on the numbers given, but then upon letters; obtaining thus formulæ, in which again they may substitute numbers.

But Sir Isaac Newton, and long afterwards, in more distinct form, Sir William R. Hamilton, have shown that there is a deeper, a more vital distinction between algebra and arithmetic, than the mere ability of algebra to deal with the unknown; it deals with the variable; it introduces conceptions of flowing, changing quantity; it is in fact a science of Time. Leibnitz

then introduced what Peirce, in his Linear Associative Algebra, has shown to be a new algebra, to deal with the infinitesimal. The increase of power given by the three gifts, Neper's logarithms, Newton's doctrine of fluxions, and Leibnitz's algebra of the calculus, has been incalculable. Their gifts have, however, been but scantily used by the compilers of elementary books, until within the last half century. They could be advantageously carried much further ; and, in spite of the famous denial, a royal road to geometry, in its widest sense, could be constructed by the labors of these three kings ; a road which would lead to new treasures of art and science for the benefit of the whole race.

A few writers on geometry have followed Peirce in introducing the infinitesimal into the elementary treatises on that science ; it is to be hoped that others will follow him and go beyond him in introducing the idea of flow or change into algebra. An anecdote will illustrate the advantage thus to be derived. A pupil of mine had labored for several days in vain to understand the demonstration of the binomial theorem. I took out my watch, and said : Now give me undivided attention for five minutes, and I will give you an easier demonstration. At the expiration of the five minutes, I was through ; and he was repeating with all the delight of success, my demonstration. In those five minutes I had begun *de novo*, from first principles, and given him a simplification of Peirce's demonstration of Arbogast's Polynomial Theorem, based on derivatives, which are the same as differential coefficients,

or fluxions. I had avoided every new technical term, and given him the ideas.

In like manner by introducing the idea of flow, early, and teaching Leibnitz' calculus with the ordinary algebra, the whole mysteries of trigonometry and analytical geometry could be brought within the range of High School instruction ; what might be done with Hamilton's Quaternions, and Ellis's Stigmatic Geometry I have not examined. The mathematical sciences are advancing with wonderful rapidity in this nineteenth century ; — but our American common school education has as yet, hardly felt even the discoveries of the seventeenth. I would at least bring them up to the position of that era.

CHAPTER VI.

Physics.

THE CHILD learns from its earliest experience some of the mechanical properties of matter; his muscular movements, which are the earliest phenomena to call his attention to the existence of Space and Time, are accompanied also by a sense of the exertion of power, and of an external resistance to that exertion. The introversion of consciousness upon his exertion does not take place until after his distinct apprehension of the resistance. The degrees of resistance soon give him conception of the gaseous fluid and solid states of the body; its fixity or mobility, rest or motion. At the same time, sight, touch and hearing are giving him with his primary conception of the shape of different objects, ideas also of light, darkness, and color; of heat and cold also; and of smell, taste and flavor. All these sensations lead to new knowledge, capable of scientific development; which, however, comes later than that in mathematics.

Fröbel's kindergarten gifts are excellent in giving the first ideas of physics as well as mathematics. All good things are, however, capable of perversion, and there is danger in his system, as in all others, of falling into a routine; endeavoring to bend nature to our

system; instead of making our practice conform to nature. The teaching of nature is incidental and infinitely varied. By incidental I mean what may be, less reverently, called accidental; it is teaching by the occurrences of the hour. The mind naturally passes from this to regular and systematic study; and we obey the law of our native intellectual power, in preparing scientifically arranged elementary text books. Nevertheless the earliest teaching of nature is incidental, and it will be found that in no other way can we begin the study of the sciences successfully in our schools than by incidental teaching; teaching in which the teacher's active and trained mind leads the child to gain knowledge from the passing events of each moment. This is the true spirit of what has been called object teaching; which I have seen degenerate in the hands of a dull and lifeless teacher, into a routine as worthless, as any stereotyped text book.

When the child of seven or eight years old is building with little wooden bricks, upon his covered desk, the teacher will, for example, have the opportunity to make clear, to the school, some of the principal properties of the centre of gravity, and of the states of stable and unstable equilibrium. He will not give the children those phrases, but will lead them to see that if the centre of a brick, or of a mass of bricks, is not supported by something directly under it, it must fall; he can make them see that if this support is narrow, the mass is easily overthrown, if broad it stands. He also will lead them to a practical recognition of the analytical condition of stable equilibrium;

that if on a slight disturbance, the building returns to its former position, it is stable.

The laws of elasticities also, and the reflection of motion, may be exemplified by the rebound of balls, the return of echoes, and the use of mirrors. At the age of eight or ten years, the average pupil will see and appreciate the difference between the more perfect elasticity of his marbles, and the less perfect of his balls; the perfect reflection of light in straight lines, and the readily refracted ray of sound. The games with balls and marbles, illustrating geometrically the parabola, and the ellipse, give us also the opportunity for incidental instruction concerning the composition of forces, the effects of an accelerating force, the ratio of momentum to velocity, and the like. We have referred to the effect upon a boy's mind of the truth that a chain supported by its ends can be straight only when vertical; a similar effect is produced when he is led to see that the path of a projectile can be straight only when it is a perpendicular straight line.

Some of the principal laws of optics, of acoustics, and of thermotics can be advantageously given to the child in this incidental way. The optical toys, which are in almost every household; musical instruments, burning glasses, and the phenomena of dew, rain, frost, and snow, give the teacher abundant opportunities. The lightning, the refractory state of the hair in dry cold weather, toy magnets, the electric fire alarm,—give occasions for incidental instruction in electricity and magnetism.

In giving this instruction tell the child only what you really know, and never be ashamed to confess your ignorance. Lead him, if possible, by judicious questions to see for himself;—when not possible, tell him clearly, what is clear to you, and confess ignorance as to the rest. A popular scientific chattering upon a subject is worse than a total neglect of it. I have heard a lecturer, to whom a hundred dollars was paid for his evening's instruction, tell an audience that zinc was decomposed by sulphuric acid, and hydrogen evolved; that a certain insect in the sea ran a circular saw at 60,000 revolutions a second, to cut up its prey; that he had made a gyroscope, weighing a pound, run so fast as to weigh but five ounces. A text book on Familiar Science, said to have sold to the amount of nearly 200,000 copies in the United States, gives, among other trash, as an explanation why soap destroys grease, the statement that grease consists of oleine and stearine, and that "when soda or potash is mixed with it, the oily principle flies off, and the stearine is converted into an oxide of potassium, which is perfectly soluble in water." Such instruction as this would be improved by the substitution of Foote's celebrated passage; "So she went into the garden to cut a cabbage leaf to make an apple pie, and, at the same time, a great she bear, coming up the street, pops its head into the shop. What, NO SOAP? So he died, and she very imprudently married the barber!" The absurdity of this would be laughable; of that, is lamentable.

One of the earliest studies, commencing perhaps

at the age of seven years, should be geography. Two modes of beginning are open to you. The first was developed in Woodbridge's geography. You begin with the school room and draw a plan of it on the blackboard, being careful to put the north side of the plan up, as that is the mode universally adopted in maps. While looking at the plan, and when studying maps, the young child should always turn in his seat until he faces north ; the older child, who has learned to " orient himself " may face in any direction. When the plan of the school room is understood, draw around it the plan of the school yard ; let the children copy it ; question them upon it, and be sure that it conveys to them the correct impression. Let them measure the dimensions of the room and yard, and draw the plan to various scales. Add now, to the plan drawn on a small scale, the map of the neighboring roads and streets, and let the pupils indicate on the map the position of their own houses. Proceed thus gradually to show them the map of the county, of the state, of the United States and of North America, and then lead them to the globe.

The other method is the one which I have usually pursued, which is, to begin with astronomy. The heavens catch the child's attention early, and he wishes to know about the sun, moon and stars. The only answer that can be made to his inquiries, in this age of the world, is to explain to him that they are large balls, and to tell him of the points of resemblance, of the moon and planets to this terrestrial ball. Then show him a globe, (being careful to have the pole

pointing towards the real pole in the heavens, and your own meridian uppermost,) and lay a marble upon it. Explain to him that the earth is a large ball or globe, under the little globe, as that is under the marble. The immense magnitude of the great globe he cannot as yet imagine ; and at first you must be content to see that he understands its form and motion. Set the globe (rectified as before) with the marble upon it, in the window seat, where the sun may shine upon it, and draw his attention to the fact that the light and shadow on the marble and on the globe are similarly situated, then tell him that the light and shade fall on the earth as they do on the marble and on the globe, making night in the shadow, and day in the sunshine. Explain how the reflection from the globe diminishes the intensity of shadow on the marble ; that reflection from the window seat partially enlightens the under side of the globe. Make the amount of reflection from the window seat more apparent by conveying it alternately with a black veil, and a white handkerchief. Now explain to them that "the earth hangeth upon nothing," floating free in space like a bird in the air ; and that is the reason why the night is so much darker than the under side of the little globe ; namely, because there is no window seat under the earth to cast a reflection upon our antipodes ; except when the moon acts in that office. Take the children out, (in the morning, when the moon is in its last quarter ; or afternoon, when she is in the first quarter) and placing a globe, ball, or marble, in the sunshine, on top of a fence or post, let

the children successively place their heads in a position to project the globe against the moon; they will then see the light on the globe will take the shape of the moon. Call also their attention to the fact that the moon is of the same brightness, by day, as a white cloud. This will give them a visible demonstration that the sunlight falls on the planetary bodies, as it does on the marble and the globe.

Now explain to the child the figures on the globe; which is meant for land, which for water: and show him his own country and the situation of his own town;—still remembering never to direct his attentention to the globe until it is rectified, (bringing the school house to the top of the globe, and making the North Pole point north). Give him brief descriptions of the character of various nations, and the climate of their countries, and show him how to point towards them, by putting a pencil point on top of the globe pointing through it to the given country, and explaining that the pencil also points through the real earth to the real country. The magnitude of the world may also be given, (the great circle being 40,000 kilometers, and the diameter being 12725 kilometers) by showing how long it would take for an express train at 50 kilometers an hour to go round; and how long to go at a slow walk of 5 kilometers. Invite the children also to go with you to the point where the most distant point can be observed, and show them on your return to the school house, that the panorama seen from that place is covered by a very small spot on the globe. Describe to them the highest mountains in

the world, and when you have led them to their liveliest conceptions, take them up the steepest possible hill, and climbing far enough to show them some town 12 or 15 miles distant, point out to them how small upon the globe would be the circle of their vision. [The square root of seven quarters of the elevation of the eye, in feet, is the radius of the circle of vision in miles. The square root of fifteen times the elevation in metres is the radius in kilometers].

Place again the marble upon the surface of the globe, (choose a mottled or marked marble,) and holding it there, show them that the rotation of the globe rotates the marble with reference to the sun, but not with reference to the globe ; that the marble is, like the globe, now this side up, now that, as the globe rotates ; but the marble keeps always the same side to the globe. Show them that in like manner if the globe stands with the same side constantly down, that is, towards the earth, then if the earth rotates, spins round, the globe, and the marble, balanced on top of it by aid of a few grains of dust or crayon, will spin with it. Propose now to see whether the earth is rotating ; by placing the globe (always rectified) in the sun shine, noting where the sun light falls, and coming at the end of the next half hour or hour to see whether it has moved. When the children have thus seen for themselves that the little globe is rotating under the sun at the rate of 15° an hour, and the marble at the same rate, show them that the cause of it lies in the great globe rotating at the same velocity. But let them see that this angular velocity

implies a greater speed in the surface of the great ball, 1200 kilometers an hour, or nearly that, according to the latitude,—forty times railroad speed; so fast is their school house constantly whisking eastward.

Now show them that by placing the globe, (rectified) in the sunshine they can see for themselves just where the sun is rising, where it is setting, where it is on the meridian, where vertical, and so on; see it on the globe, and thus know it concerning the earth; they will be greatly charmed, if you are fortunate in having a position for the globe in which it can remain some hours in the sun, showing them from hour to hour, as they return to it after other occupations, what countries are having sunrise, and what sunset. Their attention should always be called to the poles, one lying in darkness, the other in light, all day long. These lessons, with the smallest kind of globe, should be repeated in every month of the school year; and thus the scholars would gain precise conceptions of the meaning of the arctic circle, the tropics and equator, the causes of the changing seasons, and other matters of astronomical geography, more surely and accurately than in any other way. Especially care should be taken, for this end, to give the lesson at the equinoxes and solstices.

From the globe, the transition to maps, and to detailed geography or topography is easy; and in country schools may be made intensely interesting to children by occasional walks. The natural objects actually found are the best text books; the brooks

and rivers, the various soils, and rocks, the diverse kinds of vegetation, the roundness of the earth as seen in the curve of water lines, and the dip of the horizon if you climb a hill; these and many other points will readily be observed by a child when pointed out; and they may early be taught also to perceive the increased beauty given to the landscape by the illusion which invariably exaggerates vertical heights and under-estimates horizontal distances. Show them that this makes the relief maps, with their exaggerated elevations, so true to the feeling of nature. Let them also learn a similar lesson by building clay models of the hills in their neighborhood, upon a true and then on an exaggerated vertical scale.

Further lessons in Astronomy should be given by procuring a ball, of a little over one quarter the diameter of the globe, and holding it about 110 times its own diameter from the globe. At this distance, it will appear to an eye held close to the globe, of the same size as the moon, and held in the sunshine may be made to imitate the moon's changes. The endeavor, both in geography and astronomy, should be to lead the child's mind away from the illustration to the thing illustrated. It is annoying to see, in some of the best geographies, a picture of the earth floating among clouds, some of which are larger than the diameter of the earth. Such a picture will make it more, instead of less, difficult for the child to get a vivid conception of the real facts,—that the atmosphere and clouds make a covering about the earth, about as thick in proportion as the coating of varnish

about his globe; that the highest mountains, and the deepest deep-sea soundings, are but like the unevennesses in the grain of the paper with which the globe is covered. Astronomy is the most powerful among the sciences, in developing clearly the imagination in space, and its primary facts may therefore be given to children many years before they can understand the processes by which we have arrived at a knowledge of these facts.

CHAPTER VII.

CHEMISTRY.

CHEMICAL relations are evidently more abstruse than mechanical. It requires some maturity of mind to distinguish chemical compounds from mere mechanical mixtures; and yet the simplest chemical phenomena begin to excite a child's curiosity, by the time that he is ten or twelve years old; and it will be greatly to his advantage if his curiosity is gratified by correct explanation and sound principles, instead of being lulled by plausible pretences at explanation. Oxidation, especially in its two forms of the combustion of fuel and the rusting of metals, is the most prominent instance of chemical metamorphosis that the child will notice. A skilful teacher will find in the familiar examples of this metamorphosis almost daily opportunity for incidental instruction in the fundamental principles of chemical affinity, atomic proportions, stability or instability of compounds, &c. We acknowledge that this implies a large amount of intellectual life in the teacher, but one who is intrusted with the direction of these earliest movements of the expanding mind should be a person not only of some acquirements, but of some intellectual vivacity; of ability to seize upon the right

occasion and right moment to make permanent lodgment of a truth in the child's mind, and give the child a new ability to find truth for itself. There is always danger of a bungling teacher's extinguishing the child's thirst for knowledge. This may be done by diverting the attention at the moment when interest has been aroused; by discouraging with difficulties, by disgusting with tedium; or by puffing the child into a conceit that he has learned all, when he had really only mastered the merest rudiments. The great art in instruction is the same as, in letter writing, according to Weller, to make the recipient "wish there was more of it."

A boy leaves his knife out in the rain, and brings it in red with rust, another takes a nail out of the fire, and finds it nearly all converted into black scales. The anthracite is converted, in the fire, into a colorless air which flies up the chimney, and a few ashes; but about the fire blue blazes are seen. The combustion is effected by a double process on part of the coal, first converting it into one kind of gas, then into another. The iron is oxidized, into black scales by the fire, into red powder by the dampness. The child has thus before him two examples in which two different compounds are made with the same simples, and can readily deduce from them important corollaries. First, that the same element, iron for example, may be concealed under various forms; he sees the metal, the black oxide, and the red; and can readily understand when you show him pyrites, copperas, black ink, and other instances in which iron lies in a concealed

form. Secondly, that substances diverse in appearance, may consist of precisely the same elements, in different proportions. Thirdly, that the variation of proportion is not unlimited, but limited to a few definite proportions; the black oxide always containing 77·7 per cent. of iron, and the red oxide always 70 per cent. Fourthly, he can be told and understand that the element which is united with the iron in these oxides, is the same as that which unites with the coal and burns it, that rusting is a slow burning. By dropping iron filings in the candle blaze he can see that the iron may be made to burn fast, and brilliantly. The old fashioned flint and steel, may show the same thing, and also illustrate and demonstrate that heat is a mode of a motion; the friction of the flint scraping off a fragment of steel, so rapidly that the motion of the flint produces a violent vibration in the little particles of the fragment, which vibration is heat. Fifthly, he can see that a gas, like oxygen, may make a solid compound with iron, a gaseous compound with coal. Sixthly, he can thus rise to the generalization that all bodies may be considered, like water, capable of existing in the three forms; solid, fluid and gaseous. Seventhly, he can be told how universally and abundantly diffused is this element of oxygen, constituting one fifth of the air, eight ninths of the water, and one half of the solid crust of the earth. Such are a few of the chemical lessons which the young child can be led to be interested in, and to learn, from the familiar incidents of burning and rusting. Many other daily occurrences may lead to

as valuable incidental instruction on other chemical facts ; and prepare the pupil for the higher branches which are to follow.

It will be observed that all these lessons concerning difference and identity, unity and multiplicity, definiteness of proportion, and limited numbers of compounds, imply clear arithmetical conceptions, and that therefore arithmetic precedes chemistry in the hierarchy. The higher branches of chemical philosophy will also demand geometry. Few bodies, for example are absolutely amorphous, and the knowledge of crystalline forms, if nothing else, is required in distinguishing chemical compounds. Remember, in every branch to teach humility, and let the child see that he is getting only glimpses of a boundless field.

CHAPTER VIII.

MINERALOGY.

A PRELIMINARY knowledge of the meaning of chemical relations having been acquired, the pupil is ready to classify the substances actually found in nature. In the "Evenings at Home" of Dr. Aiken and his sister, are some admirable examples of early lessons in mineralogy, botany and zoology. The "Harry and Lucy" of Maria Edgeworth contains equally valuable lessons, and a school teacher may find aid in learning how to present scientific truths to the child from these works.

Among the early incidental teaching in mineralogy will be the introduction to the group of metals; those anciently known, together with the modern platinum, nickel, antimony, bismuth, and aluminium, can readily be furnished to every school house. Alloys may be shown in sufficient number to illustrate their nature; especially brass, bronze, pewter, and other commercially important mixtures. The mode of obtaining these metals, from their ores, and the chemical nature of their ores; mechanical properties, uses in the arts, and in medicine; history of their discovery, and the like will furnish many topics for conversation. The usefulness of iron alone, will

furnish food for many hours at different times. The rarer metals may less seldom be shown ; but some of them, as sodium, potassium, calcium, lithium, osmium and iridium, will be so naturally suggested to the teacher's mind, by familiar objects in the school room that she can hardly avoid telling the children something about them.

When a school is situated in the country, especially when that country is rich in a variety of minerals, the scholars should be invited to bring, to the school room specimens of all that they can find in their Saturday rambles. The different kinds of rock and earths, should be referred to their nearest species ; and the uses of each kind, in building, plastering, making brick, farming, and so on, should be explained. There will always be some one in the school district or in the town to whom the teacher can apply for information if the child chances to bring in an unrecognised specimen. When the mineral is crystalline in its form, be careful to draw the attention of the pupil to its precise shape, even to the minutest feature. When the mineral is amorphous call attention to that fact.

Gases do not present, in visible natural forms, any great variety ; but the four or five elements constantly found in the atmosphere, with one of which his chemical studies began, may be described.

CHAPTER IX.

PHYSIOLOGY.

THE legislatures of our various States, and even their Committees on Education, are not infallible. To require instruction in physiology in the common school, as ordinarily constituted, is to require babies to make bricks, and that without straw. The superficial thinker, readily perceiving the mode in which arithmetic is applicable to practical life, exaggerates the value of the study as a means of education, and defeats his own end ; not even teaching the child to cypher as well as he would do, were arithmetic confined to its proper narrow boundaries. In like manner because the application of human anatomy and physiology to the practical care of the health, is obvious, many teachers and legislators have pressed with great zeal the introduction of those studies into the primary schools. But the study of the human body and its functions can be made much more effective, more interesting, and more valuable, if it is preceded by lessons upon zoology and botany. In the order of nature, the plant lives upon inorganic food, and the study of vegetable physiology, must come after the study of mineralogy ; the animal lives upon the plant, and vegetable physiology must precede animal. In

the order of nature the child's attention is most forcibly attracted by what is external; and by what is foreign to his own body, before it is by his own members. It is an unnatural, an injurious thing to turn the child's attention too early to the functions of his own organs. A better result, both intellectually and morally, will be attained, if the teachers and parents take care of the diet and exercise of the child; his clothing, and the temperature and ventilation of the rooms in which he sleeps and studies; at least until the age of thirteen to fifteen years. It must be confessed that teachers and parents are themselves sometimes terribly ignorant, or perverse, upon such subjects. I have seen, highly educated and cultivated people urging mere infants to eat rich cakes and scalloped oysters; and giving cakes and candies to older children between meals. Nevertheless the cure for such terrible abuses is not to be found in teaching physiology to children, but in teaching it to young men and young women, before they have the care of children providentially intrusted to them.

The mind must be prepared for understanding physiology, by previous instruction in botany and zoology; and the observing powers being at the same time thus developed, will prevent the danger that the introduction of anatomy and physiology will lead to premature and excessive habits of mental introversion. The study of one's own body approaches nearer to psychology, forming a natural introduction to it; and should, therefore, come last among the studies of Natural History. I mean to say that the study of

human anatomy and physiology naturally and inevitably leads a child to make psychological investigations into the facts of consciousness, involved in the exercise of the functions of his own frame ; and this is not a wholesome process for him before the age of fourteen or fifteen years, if even so early.

CHAPTER X.

BOTANY.

INASMUCH as botany, although it depends upon chemistry in its physiological department, classifies plants solely by their texture and form, some knowledge of the common weeds, and flowers, the trees, grasses, mosses and lichens, of the neighborhood, may advantageously be given to a child as soon as it is old enough to distinguish them. Even in the cities the shade trees, gardens, and yards offer an opportunity for gathering specimens. In walking from Franklin street, through Arch to Summer street, Boston,—not more, I suppose, than 125 or 150 meters, in thickly frequented streets,—I saw thirteen different species of plants, crouching against the foot of the walls, and rooting between the bricks of the pavement. It was thirty years since, and I do not recall them, but presume there were two or three mosses, two or three lichens, as many grasses, and perhaps shepherds' purse, knot grass, wild pepper grass and plantain, with one or two clovers. Linnaeus is said to have found 81 species in a square yard. One might say of plants what Professor Cleveland used to say of minerals: "You can find almost any species in Topsham, if you will look for it."

From the day that a child enters the sub-primary school, I would have it receive oral instruction in botany ; illustrated when possible, by living plants ; if not, by pressed plants, or even by good drawings. At first the child may be simply taught to recognize different species at sight ; just as he knows a man, a woman, a horse or a dog ; that is, he may simply learn to say on seeing the plants : This is a sugar maple ; this a Norway maple ; this is a lilac ; that a white birch ; this a white pine ; that a yellow pine ; this a sweet violet ; that a bird-foot violet. Afterwards he may have a sprig of sugar maple, and one of Norway maple, given to him to study. Let the class look long and carefully at specimens of two allied species, and then try which one can point out the most, or the most important, of the differences between the two.

In the first volume of Agassiz's Contributions to the Natural History of the United States, he gives an essay on the principles of zoological classification. He shows that the animal world is first of all divided into four distinct plans of structure. Zoologists who believe in gradual evolution attempt to belittle the importance and accuracy of this division into four plans, but it rests on necessary mathematical foundations ; and the glory of Cuvier will not pale before that of Darwin. Each of these four great branches is, according to Agassiz, divided into classes, according to the means employed in carrying out the plan of its structure. Each class is again divided into orders, according to the general degree of complexity or simplicity of the organization. Each order is again

divided into families, distinguished from each other by the general outline of their external form. Each family is divided into genera, distinguished from each other by the anatomical detail of the feet and mouth. Each genus is divided into species, distinguished from each other, by the difference of their relations to the external world, and to members of their own species.

No botanist has done for plants what Agassiz has thus done for animals. Yet there is, doubtless, a close analogy in the principles of classification that must be adopted in botany to those that hold in zoology. And as in animals the easiest division for a child to recognize is that of families, because it depends upon external form ; so among plants, the child will more readily appreciate the likeness among members of a well defined natural family, or tribe, than any other botanical likeness. I have known a child of very tender years, and not at all distinguished for accuracy of observation, call a succory flower, at first sight, a blue dandelion.

When, therefore, the child is able to point out similarities and differences, from its own independent observation, between different flowers which it brings in, it may be taught to observe family likenesses ; to see, for example, the relationship of the oak to the hazel, in their catkins of staminate flowers, and the involucre surrounding the nut ; or the kindred of the alder to the birch in having both kinds of flowers in scaly catkins, with two or three flowers under each scale. The greatest care must be taken not to allow the child to think that a few words embody all the

points of resemblance which characterize a family. He must ever be led to perceive the unity of each organism; that the oak and the hazel, for example, differ from each other in every single point wherein they can be compared; yet have also a certain family likeness in every part; and his definitions simply seize upon the likenesses that are easiest to describe, not upon those which are most vital.

Much less should the child be encouraged or even permitted to repeat formulas on such subjects by rote. The very objects for which such studies are introduced into our schools is defeated when the children are allowed to commit the words of the text book to memory. Yet so accustomed are some teachers to this mode of instruction; so incapable, apparently, of conceiving of any better plan, that I have known teachers to require their pupils to repeat the very words of Dr. Gray's "How Plants Grow," and of my own "First Lessons in Geometry." I have no doubt that Miss Hall, "Our World," Miss Youman's "First Lessons in Botany," and Prof. E. S. Morse's "First Book of Zoology," are abused in the same manner, so difficult is it for teachers to understand that the natural objects themselves are the true text-books; and that the words written by men are nothing in comparison with the lines of nature, whence the true man of science gets all that he can record.

By having the children collect and bring to the school-room the common flowers and weeds of their neighborhood; and by leading them to examine and compare the flowers and seed vessels (and to some

extent the foliage also), they can, without the slightest strain upon their mind, or memory, before they are fourteen years old, be taught to recognize at sight any one of three or four hundred common species ; and to refer the greater part of them, at once, to their natural families, and recall the principal characters of the family and its uses in the arts and in medicine. No book need be placed in their hands. The teacher should have Dr. Gray's books, and any others as adjuncts, to refer to as a basis of oral instruction ; but the child should study the living plants, or dried ones, or good drawings. I am speaking of the sub-primary school ; the instruction of older pupils is less difficult and less important.

CHAPTER XI.

ZOOLOGY.

ZOOLOGY is not forced upon the child's attention by nature so constantly as botany. The plants stand to be examined at every step of his pathway. Yet the motion of animals, and still more, their intelligence, makes them more interesting and fascinating to most children than plants. And although physiology demands a knowledge of chemistry, yet the classification of animals, like that of plants, depends primarily upon their organic structure, their external form, and upon their manifest relations to the external world. A child of five years old is interested in watching animals ; and I have even known a child of half that age to watch insects and toads with the closest attention, again and again, patiently observing their habits ; and he may readily be taught to distinguish and name many of the creatures which he thus observes.

In a country school-house, in the month of May or June, it frequently happens that the notes of thirty or forty different species of birds are heard in the course of a single day. It would be no waste of time, but on the contrary, a thing of inestimable value, should the teacher enable his pupils to recognise each species by

teaching them to learn their appearance also and habits; and perhaps tell them the family to which each belongs.

In teaching the names of birds and flowers there is a great difficulty which we may as well boldly face. When the child has learned to recognise a plant or an animal at sight, it becomes almost a necessity to give him a name for it; if you do not, he will name it for himself. But many of our familiar weeds and birds have no common names; the common names of many are also very inappropriate. English names are given to our American objects; and when the child reads, in his school-books, selections from English literature, he brings up a wrong picture of American instead of English scenery. Adults of some culture, are constantly subjected to the same cause of error. In one of Wilson Flagg's interesting volumes he confuses the Roxbury Waxwork (*Celastrus scandens*) with Bittersweet (*Solanum dulcamara*), attributing the medical properties of the latter to the former; and I have known others hearing the Bittersweet (*S. dulcamara*) called Deadly Nightshade, immediately assume that it was Belladonna. Thus, also, the name of Woodbine (fragrant monthly honeysuckle) is in this country given to the Virginia creeper, which is a sort of five-leaved grape; the name robin is given to a thrush; the name ivy to a poisonous climbing sumac; the name pennyroyal to a plant which smells like it Other common names are worthless from either being local, or from being differently applied in different States of the Union. Thus, our American plant

Gaultheria, is called in some sections Wintergreen, in others Chequerberry, in others Pine Ivy, in others Partridge-berry, in others Tea-berry. And the English word honeysuckle is applied not only to the genus and family of the Woodbine ; but in various parts of the United States is given to Azaleas, Diervillas, Columbines, and Clovers. In one of Emerson's poems he speaks of "blinding dogwood" ; by which, as a New England man, he means the poisonous Swamp Sumac ; but a man of the middle Western States would be greatly perplexed to know why Emerson should call the beautiful flowering and cornel "blinding."

The common names of fishes, and of birds are in this country in the same state of confusion ; the fishes perhaps even worse. Care should be taken with children to give them from their earliest acquaintance with the plant or animal, a name which will not thus mislead. Let them understand that our pennyroyal is "American" and different from the European ; that our lark is not the singing lark of which English poets speak ; that our robin is not the robin-redbreast of the old world, but is more like a thrush ; and that our blue bird is nearer being a blue-breasted robin. I hardly need say that the child should be taught to call a columbine by its name ; and reserve the word honeysuckle for the genus Lonicera and its closest congeners. Nor need the teacher fear giving, where there is no good common name, the scientific name. Many scientific names, (such as geranium, fuchsia, eschscholtzia, clarkia, abutilon, althea, syringa, rose, violet, crocus,) are as familiar to lovers of flowers as any com-

mon names can be. If the child hears no other than the scientific name he remembers it as readily as he will an English name.

Poets have sometimes expressed the fear lest a scientific acquaintance with nature should destroy its beauty; lest the song of the bird might seem less melodious if you called the songster by a barbarous Latin name. On the contrary, a closer acquaintance with nature only increases the pleasure of one who truly loves her. The beautiful in nature is always more beautiful than it at first appears to us; and if we lose our appreciation of it, the fault is in us and not in the object. "Nature," says the Concord seer, "never became a toy to a wise spirit." The wisdom and beauty embodied in each specimen of organic life, is "not only vast, but infinite"; so that there is no possibility of the closest study exhausting it.

The insects in any given country are usually more numerous, in species, than the plants. The mysteries of insect transformation, the wonderful mechanical instincts that many of them display, the brilliancy of the colors of some, and the pertinacity with which others thrust themselves upon the attention of man, render insects peculiarly fitted to engage a child's attention, and to serve as a basis for "incidental" instruction in zoology. In this class of animals the orders are more conspicuously distinguished than the families; and for convenience, in talking about the specimens which are brought in, it may be best to group them at first simply in orders. They are, in general, easily preserved, and I would have, in every

primary school, a collection of the most common species of the neighborhood, scientifically arranged in boxes with cork bottoms and glass tops. These would be better than books, to serve as a reference for any insects which the children might catch and bring in.

The field of zoology is vast, and even entomology is more than sufficient to occupy a lifetime. Yet on account of this very magnitude of the field, the child's attention should be early directed to it; so that, if it be one for which he proves peculiarly adapted, he may have the advantage of an early beginning. But whether he pursue it in after life or not, the study of zoology and botany in the earliest years is important for the intellectual discipline which it gives. In the erroneous education of the present day, intellectual discipline is supposed to be needed only for the reasoning powers; whereas it is needed for all the faculties; the observing and the imaginative as well as the reasoning; and should be given in that order, the child being first of all taught to observe, to see with the outward eye. The main object of these first lessons in natural science is to induce the spirit of patient exactness in observation; calling the child's attention to differences as carefully as to likenesses, and to the fact that likeness in one part my co-exist with diversity in another; that the likeness may be conspicuous and the difference obscure; or on the other hand, the differences obvious, and the likeness in miniature. Nevertheless, while the main object is to cultivate a spirit of observing patiently and accurately for oneself, a second object is not to be lost

sight of ; which is to place incidentally, as opportunity offers, before the mind of the pupil, general principles, already discovered, and firmly established by the inductive philosophy ; principles which may assist the pupil in the guidance of both his sense and his reason, in his future studies, and in his daily business.

The evils of introducing the child too early to the consideration of human physiology have been already mentioned. Comparative anatomy will be usefully introduced to his notice much earlier. The homology of the parts in vertebrate animals with those of his own body, forces itself on the attention of the youngest child who plays with a kitten, or watches a toad. He may readily be led to see the homology in the more remote forms, even in the fishes, while the difference between the limbs of the vertebrates, and the organs of locomotion in the invertebrates must also be carefully pointed out. Thus these studies will gradually develope, without conscious effort on the part of pupil or teacher, a power of judgment and of reasoning independent of forms of language.

Prominent among the reasons why the studies of Natural History should be introduced into the primary schools, is the fact that it accords with the usual tastes of children, as well as with the natural order of intellectual development. Children are always interested in looking at crystals, plants, flowers, insects, shells, birds, and beasts ; they are interested in intellectual and spiritual truths only when dressed in living figures. They cannot understand the thing signified unless they first know the facts through which it is

signified. Nature, like the Gospels, speaks in parables to those who cannot understand the truth in other forms ; and children are pleased and instructed when allowed and encouraged to read those parables for themselves. Nor is there any purer, or more permanent source of happiness and of wisdom that can be opened to them, than this habit of reverently reading for themselves, the lessons of nature.

The principles which I am endeavoring to apply in what I say of the subprimary and primary schools, are easily applied to the whole course of liberal education; —by liberal education I mean that education which fits one for the social and political duties of a freeman ; without rigorously excluding every thing that might be considered as professional training. For liberal education, the course of physics should, in proportion as the pupils mind enlarges, deal gradually more with general laws, and less with the details by which those laws are established. The ability and habit of patient and exact observation having once been gained, then the wider and more general the principles which you give your pupil, the more practically useful will your teaching be. This is the true method of the Novum Organum ; *ascendendo ad axiomata, descendendo ad opera.* Physics and Natural History were thirty years ago unjustly neglected in our general education ; there is danger to-day lest, in the reaction, they are allowed to claim an unjust portion of attention. They belong, as means of liberal education, to the schools more truly than to the colleges; in the latter their place is rather as a part of philosophy,

than as a training in observation. History, literature, politics, psychology and theology are the more appropriate studies for a collegiate course.

In the grammar and high schools, after a proper preparation in the younger grades, we can readily give as much of the mechanical sciences, and sciences of natural history, as it is profitable to teach to those who have no special aptitude for the studies. I acknowledge that this is impossible with the preparation now given in the primary and subprimary schools; and that, therefore, a part of the collegiate course is necessarily occupied in giving instruction in the physical sciences, better adapted to children than to youth. The preparation of such excellent text books as Guyot's Earth and Man, and of Agassiz and Gould's Zoology is thus rendered a thankless task; these books, adapted for the widest usefulness in high schools, are, by the insufficient preparation of the younger scholars, confined to a few of the most advanced institutions. Within a few years past, good text books have been prepared in Geography, Botany, and Zoology, for younger children,—very good, if they be used, as some of the best were meant to be, by the teacher alone, and the child have the globe, the plant and the animal put into his hands for study. It is absurd to attempt to teach from text books alone; and in the most modern style of text book, each subject is expanded so fully that the child who studies his school text books has no time left in which to play, much less any time to study nature; and the teacher who examines the pupil, in so called recita-

tions, sufficiently to know whether it has studied the whole of the text book, has no time left in which to teach anything.

Changes in the system of public education are usually made with difficulty ; and it is, doubtless, well that it is so ; since, otherwise, our schools would suffer, even more than at present, from the eccentricities and errors of those who have control over them. At present, the legal guardians of the school, the teachers, the scholars, and the parents, constitute four classes, who resist every change, whether for better, or for worse. In the changes which I have been advocating now for thirty years, the difficulty has been greater from the fact that the proposed alterations require an alteration from the very beginning of the course, in the alphabet school. It must be confessed that my scheme of high school instruction is impracticable, unless the pupils have been from their first entrance into the lowest school, trained in habits of exact observation, and rapid, accurate conception ; and taught to grasp and become familiar with the results of sound inductive reasonings.

So far from this being the case in ordinary schools, we might more truly say that there the child is taught to neglect observation, to withdraw his mind from any healthy interest in things around him, to value words above ideas, to repeat phrases to which he attaches no meaning, to adopt the results of hasty and unsound speculations. Even to the present day there are very few schools into which minerals, plants, or

animals are ever brought for examination ; very few teachers who themselves know the difference between a moss and a lichen, a bug and a beetle, a moth and a butterfly, or who would not reprove a child for bringing such things into the school room ; in nearly all schools the pupil is taught to spell, that is to deny the truth of his own sense of hearing ; and this is done so pertinaciously and thoroughly that by the time that he leaves the high school he hears in a spoken word sounds that are not there, and fails to hear sounds that are. Drawing has been largely introduced into the schools within a few years, but not for the reasons for which the soundest writers on education have urged it. Commercial, financial reasons have led to its introduction ; in a form which, however valuable, fails to give it its highest value ; it is drawing from a copy, and thus but feebly exercises the observing powers ; or it is inventive drawing, which does not develop the observing powers at all. Arithmetic was after a long struggle against the tyranny of grammar introduced into schools, and has now become a king stork more intolerable than a king log. It owes its popularity to the obviousness of its practical applications ; but it is pursued, at the present day, principally as a premature drill of the reason, and thus the practical end of learning to cypher is lost, with no counter-balancing advantage ; and the study occupies, in the ordinary school, at least double the time in which it could be thoroughly acquired, if it were made first a matter of direct sight, secondly, practised as an

art, and lastly studied as a science. Geography is the only study in the ordinary school which can be called a science of observation, and even that is taught as a matter of imagination, the things seen in the ordinary school being words and maps, not the real earth and sky. All these points show that the ordinary schooling in the primary school gives no sort of adequate preparation for scientific instruction in the high and grammar schools.

For this reason, I occupy myself more especially in indicating what I conceive to be the true time and mode of beginning each branch of study. I pass by the studies of the high school and the college, not from want of interest in them, but from a conviction that he who would produce the highest educational effect must begin with the youngest pupils. Each days mental state depends, in part, upon our previous education, the mental development of to-day, depends in part upon the education of yesterday; and that of yesterday, upon that of the day before. We must acknowledge this, even if we do not, with Herbert Spencer, consider our mental development as the culminating result of the education of our ancestors through countless generations. Moreover we must acknowledge that a stronger impression is made upon a young person than upon an old; that, although one is never too old to learn, he soon becomes too old to learn easily. I simply would express my earnest conviction that the best time for the cultivation of geometric ability, and the power of observation, is in very early

childhood; that we do a grievous wrong to our young children by drawing their attention from objects of natural history, and things which they can handle, and by forcing them to pore over a false alphabet, and Arabic figures which have no interest for them.

CHAPTER XII.

GEOLOGY.

WHEN the pupil has some clear ideas concerning the present condition of the earth and the solar system, his natural instincts will lead him to inquire concerning the ancient history of these bodies. The majority of school-houses in the United States are built upon the drift, or upon alluvial deposits. A child of any activity of mind, brought up upon the drift, will at a very early period perceive that the pebbles around him are fragments of rock, rounded and worn smooth, by some, to him, unknown agency. The boys with whom I played in my childhood were continually speculating concerning the rounded pebbles of silex and jasper scattered over the red sandstone of Central New Jersey. The children of Norfolk county, Massachusetts are forever questioning concerning the great lumps of pudding stone scattered over the ground. In Ohio and other Western States, the children, playing in the streets of the cities, stop to ponder over the fossil imbedded in the limestone slabs with which the sidewalks are paved.

It is only within forty years that any very satisfactory answer could be given by teachers or parents, to children questioning them upon these things.

When Agassiz first gave a rational answer to inquiries concerning the drift, even the most learned geologists refused to accept it, and clung to their inadequate, and confused notions of water and floating ice ; which the healthy intellectual instincts of children rejected as wholly inadequate to explain the problem. But twenty years of battle for the obvious truth was at length successful, and the existence of a glacial period, as the immediate precursor of the present epoch, is so well established now, that there need be no hesitation in giving it to children as a fact. In like manner the older truths, of the long succession of preliminary ages, and of the deposits of mud, afterwards hardened into stone, around animals which have long since perished from the earth, may safely be given as facts, more interesting than any fictions—

Through the window we are peering
Into ancient realms of shade ;
Lo ! instead of ghosts appearing,
Creatures, like the present made.

None of Pluto's fabled terrors,
Neither Sphynx, nor Harpies dire ;
Nor Chimaeras, (fearful errors !)
Lick up hell-born flames of fire.

No ! within these quiet places,
Daemons foul no vigils keep;
But a thousand dreaming races
Lie in an eternal sleep.

In old time, the Sun arisen
Made, for them, the world shine bright;
Now the rocks their forms emprison,
Closed in everlasting night.

So sings Oswald Heer; and the child is as much entranced with the new stories as with the old. Only let due care be taken to distinguish as accurately between facts and imagination in the new forms as in the old. In Darwin's "Voyage of the Beagle" he closes with an emphatic warning, which, it seems to me, he himself, thirty years afterwards, entirely disregarded; an emphatic warning against the temptation, which constantly assails the student of geology, to bridge over the gaps of knowledge by loose and unfounded speculations. His warning needs to be earnestly repeated at the present moment, to the teachers of the young; since his enthusiastic followers are constantly assuming that his recent speculations are established inductions and have the authority of science. There are facts enough established in this science,—the origin of fossils, the formation of ancient and modern rocks, the origin of the drift, and of alluvial deposits, the nature of the various coals, and coal oils, the formation of continents, the direction of the great mountain chains and coast lines, and its connection with the obliquity of the Ecliptic, the duration of the present epoch,—to give to the child as incidental opportunities occur; facts which will enlarge the scope of his thought and imagination, and prepare him to receive new truths as they may be presented to him in after life.

CHAPTER XIII.

COMMODITY.

OUR third great division of human science includes all that is historical,—all that relates to man's action, what he has said and done. This division, as we have already said (p. 18) may be roughly divided in four groups ; the first treating of man's use of nature for commodity ; that is, for purposes of agriculture, manufactures or commerce. The second embraces the fine arts ; the third, language ; and the fourth, social life, custom, and law. The reasons for this subdivision, and for the order in which the groups are arranged, will be evident on a moment's thought. The use of the world for our bodily needs is first in order of time and of simplicity ; the earliest knowledge that a child has of the work of man, as distinguished from the work of nature, consists in knowing to what uses man puts the material things furnished by nature. We must, however, confess that this precedence is logical rather than chronological ; since the child has been in the world but a year or two before it uses dolls, and pictures, that is, works of art, as naturally as it does food or clothing. The invention of language is more manifestly subsequent to the use of material things ; and it is also manifest that the ability to com-

municate ideas by language must precede every attempt at social order or law.

Without historical knowledge, a child would grow up a barbarian. The educated man, and the highly civilized nation, are chiefly distinguished by their adding to the inheritance received from their fathers, a knowledge of what that inheritance is, and how it was gained by those who have transmitted it down the ages. Yet the history of manufactures, commerce and agriculture is seldom taught in the schools. Books on trade, on commerce, on the economy of manufactures, although recommended by many of the best writers on education, have never enjoyed a wide popularity. The great obstacle here, as in all the historical branches, consists in the multiplicity of details which seems to be involved. It is with difficulty that the good teacher finds general principles cover the facts of agriculture, manufactures and commerce ; and he knows that a knowledge of general principles is the only knowledge practically useful in the highest sense. Instruction upon these matters remains, therefore, at present, almost wholly "incidental"; and is received in the family more than at school. A very young child, is, however, greatly interested in, and benefited by, even such instruction. In the cities, let him see the planting of seeds and bulbs in pots, and watch the growth of the plants in the school-room window ; in the country let the same lesson be given in a bed in the school yard. The processes of planting, watering, weeding, loosening the surface, manuring, (in the city with nitrate of ammonia), pruning, collecting the

seed, etc., will furnish abundant opportunities for the most valuable incidental instruction; concerning the dependence of man and animals upon plants; the uses of the atmosphere and rains; the right of man to remove plants when out of place; the ethical objection to a needless destruction of them; the nature of the dew, and of evaporation; the arrangement of the leaves to catch the light, the necessity of light for green-leaved plants; the adaptation of different plants to different climates and situations; the various parts of plants used by man; the modes of increasing the yield, and of arresting the deterioration of soils.

Again, every one of the articles in household use may furnish lessons concerning the mode in which men bring the raw materials into subservience to man's needs. The processes of grinding and bolting wheat; of fermenting and baking bread; of planting, tending, gathering, cleaning, carding, spinning, weaving, bleaching, dyeing or printing cotton; of tending sheep; of shearing and cleansing wool; of spinning, dyeing and weaving yarn into the various kinds of cloth and carpeting; of tanning leather and making boots and shoes; of manufacturing glass; of digging and smelting ores and working metals;—in short, of producing from the raw material any one of these articles which the pupil daily sees and handles,—will furnish subjects for valuable instruction; even if the details are forgotten, the general impression remains, of the multiplicity of human industries, and the utter lack of excuse for any man being a drone in this busy hive, the earth.

If the teacher is ignorant concerning such matters, the school ought to be furnished with reference books, like the Penny Encyclopedia, or Chambers', or the American Encyclopedia, or at least with smaller books prepared expressly for the young. Undoubtedly the best mode of instructing a child concerning any of the operations of the useful arts, is to allow him to see the process going on ; and, whenever practicable, this course should be adopted. It is not, however, always convenient for a manufacturer to be interrupted by visitors ; and in some places it would be dangerous to allow children to pass among machinery arranged for work, and not for show. But advantage should be taken of those places where work can be seen without interruption to the workmen ; and especially of industrial exhibitions, and mechanics' fairs.

Beside the enlargement of mind, the extension of the circle of ideas, the increase in the power of conception,—which a child must gain from the examination of agricultural tools, labor-saving machinery, and processes of manufacture—he will be likely to choose his occupation in life more intelligently, and with a more just reference to his own powers. The attraction which figured so prominently in the socialist's theories, cannot have fair play and bring the young man into his appropriate sphere of labor, if this opportunity has not been afforded him of knowing what spheres are open to him. A history of inventions, a book containing the first rudiments of agriculture, "Babbage's Economy of Manufactures," and similar works ought to be embraced in the child's reading.

Miss Edgeworth's "Harry and Lucy" answers tolerably in school use; also, the "Evenings at Home"; but I am not acquainted with any modern imitations that handle these subjects well, although there are several treatises which are better than nothing.

CHAPTER XIV.

ART.

THE moment that man's bodily needs are satisfied, he begins to express his feelings in art. Music, and dancing, sculpture and painting, are as natural to man as eating and drinking. The child of two years old makes anything into a doll, and recognizes in the rudest picture the designed resemblance to man or dog, tree or house. Even the likeness to individuals, in the photograph, is thus early recognized. At three years old, the child begins to sing; and readily catches a melody.

In the kindergarten, the child begins at an early age to model in clay; and it would be a great boon to our children could something cleaner than clay be invented, sufficiently cheap to allow this feature of Fröbel's system to be adopted in all the public primary schools.

Drawing has of late years received increased attention, and Walter Smith's system of instruction seems to leave nothing to be desired as an introduction to drawing as an industrial art. For the purposes of intellectual and artistic education it needs, however, to be supplemented by drawing from

nature ; else it fails to exercise its peculiar power as a stimulus to observation, to purity of taste, and to appreciation of natural beauty. The leaves brought in for botanical study, or even the pressed leaves, kept in the school-house for types of reference, make excellent copies for the young draughtsman ; as do also the shells and insects, which ought to make part of the common school furniture. The young observer will not see the peculiarities of the natural object, nor its graceful beauty, until he attempts to copy it with the pencil. I have alluded to Agassiz's saying that a lead pencil is an excellent microscope ; Professor E. S. Morse, in his admirable First Book of Zoology, expands the idea by saying that "a specimen or figure may oftentimes be carefully studied, and yet only an imperfect idea be formed of it ; but when it has once been copied, the new points gained repay all the trouble spent in the task."

The first lessons must, of course, be in copying the simplest forms of leaves and shells ; afterwards, the more complex forms ; then the insects. When considerable facility in drawing has been obtained, and the power of accurate observation gained,—greater quickness of perception may be formed by a process similar to that recommended in Arithmetic and Geometry. A new leaf, or shell, may be exposed to full view for a short time, shorter in proportion to the proficiency of the class, and then covered, while the class copy the outline from memory. Drawing thus from nature, and especially from fresh,

living plants and animals, stimulates the pupil's powers of observation and conception to vastly higher activity, than drawing from copies; giving him greater pleasure, and greater increase of power. By this means, progressive courses in drawing from copy, and in invention from the suggestions of nature, will be made much more profitable.

The real order of procedure in education has never been so much neglected in music, as in the other arts; yet great advances have been made within the past twenty years, and the most admirable results obtained. Singing has been very extensively introduced into public schools; and, although in many places a mischief has been done by requiring the children to scream, and by misleading their ears with a pianoforte, always out of tune, the mischief has been overbalanced by the good. In other places, and especially in Boston, the advantages have been gained almost without a mixture of evil. The pupils are taught to depend upon their own ears, to keep the tones pure, soft and natural, to read the musical staff as easily as a printed page, and to give the absolute pitch as easily as they give the true vowel or consonant sounds of the language. The selections also in the Readers are made with correct taste, from standard authors. Were such instruction as that given by Luther W. Mason in Boston, given in the schools generally, it would be impossible to circulate the books of psalmody and Sunday School hymns which are now by their popularity a disgrace to our country, and to our race,—from the flatness of their words and

their music. The great end of teaching art in the public schools is not to create artists, but to give all the pupils more enjoyment in a true appreciation of art and of nature.

CHAPTER XV.

LANGUAGE.

THE study of the very extensive group of historical sciences included under the name of language, logically follows the study of labor and of art; we must know things before we can talk about them; and language logically precedes the study of law; we must communicate our ideas before we seek to enforce them. But practically, in chronological order, the study of language begins at the moment after birth, and by the time that a child enters the public school, he can talk somewhat fluently. The first point of instruction will naturally be to teach him to read and to write the language which he has already learned to speak.

The words which he uses are in his mind signs of things, and he has no more analysed the parts of a word than he has analysed the parts of the thing it stands for. At first this is the best method of introducing him to the printed language, not to its letters, but to its words as wholes. As when you hold up the picture of a dog, and ask what it is, you do not wish him to say, "It is the picture of a dog," nor that "it is one side of the head, one hind leg, and both fore legs of a dog," but when he sees the picture, you wish

him to say, it is a dog ; so when he sees the printed word, you wish him to say, not dee oh jee, but dog. Teach him thus to read very simple sentences, containing only the most common words, by pronouncing at sight each word, and continue at this for some months, until the child recognizes instantly, at sight, about a hundred words of our language, such as are used in his primer, and have been copied in writing text upon the blackboard.

When this point is thus practically established in his mind, that written and printed words are individual pictures of spoken words, we may begin the analysis of the words into their elements. If now the primer has been in the Cincinnati Phonotype, your task is delightfully easy ; if in Dr. Leigh's Pronouncing Orthography, it will present some difficulty ; and if you have only had the ordinary type the difficulties will be greater than in any part of the whole course of education.

The first step, in either of the three cases, is however the same, and is easy ; the child must be taught to analyze by his ear, the spoken word, which he can do by simply pronouncing it *very* slowly. He will soon discover that all the sounds of our English speech can be divided into about forty classes, each one of which may be called an elementary sound. This sounds learned, and beyond a child's reach ; but practically the best way to teach a child of three years old, to pronounce a difficult word, is to make him pronounce the phonic elements of it separately and successively, and then blend them. This is pho-

netic spelling, and a child of five or six years old will grow enthusiastic in such spelling, as an amusement, before he knows a single letter of his alphabet.

When the pupil can with facility analyze the spoken words into their phonic elements, he must be taught that alphabetic writing originated in an attempt to represent each element by a letter. With the Cincinnati alphabet this is done for English; and the child has but to learn the sound of each letter, in order to read. With Dr. Leigh's type, or with common type, the child must now be taught that this original attempt of alphabetic writing is very imperfectly carried out in English; that he will find each letter has various sounds, or is sometimes silent; and that each sound has various modes of being represented in words. Great care must be taken not to let him use, or even know, at first, the *names* of the English letters. For instance, A must be named as it is pronounced in at; B must be named simply as pronounced in hub, whispering inaudibly the hu, and pronouncing aloud the mere end of the word; C as in the end of music; D as at the end of had; G as at the end of hag, &c. Not until the child is perfectly familiar, by many months practice, with the fact that H signifies a slightly roughened breathing, ought it to be allowed to call it aitch.

Unfortunately the English alphabet contains but twenty-six letters, three of which, c, q, and x, are superfluous; while the sounds which ought to be represented are from 34 to 40. And in addition to this necessity for using the same letter to represent

different sounds, (as for example, t in bat, bath, bathe) we add the unnecessary use of various letters and combinations to represent the same sound, (as for example, nay, neigh, nail, nation, they, fête, and other ways of writing the sound a). Some writers have maintained that there are but trifling exceptions, and that the mass of our language is truly phonetic. But this is a mistaken view; the exceptional words occur so frequently that not only is a child unable to pronounce a new word by the aid of his alphabet, but no scholar of whatever ability can tell the pronunciation of an English word, which he has never chanced to hear, or to see printed with diacritic signs. It may therefore be justly said, that English is, like Chinese, not alphabetic in its dress, but logographic ; and there is no man living, in England or America, who has learned, or can learn to read it ; that is to pronounce anything and everything written in it.

For this reason learning to read, being the attempt to accomplish an impossible thing, is the most difficult task undertaken by an English child. A tough constitution resists a great deal of hardship and abuse ; a vigorous intellect frequently survives the labor of learning to spell in the ordinary mode. A man who has lived through a course of bad diet, and inattention to the laws of health, is apt to regard attention to such matters as a mark of effeminacy ; and, in like manner, those whose love of literature has not been quenched, and whose power to see truth has not been wholly blinded, by the ordinary mode of learning to read, suppose that there is no urgent need for im-

provement. He who will reflect, however, seriously, upon the absurdities of English orthography, and upon the gravity, with which those absurdities are usually introduced to the child as reasonable things, must perceive that such instruction has an injurious effect upon the child's mental powers, and upon his love of truth. The boy may survive it; as he survived in olden days compression of swathing bands, drenching with herb-teas, and drugging with cordials; I will even allow that, in the case of great native vigor of mind, the injurious effect may be small: but it is always pernicious; and in the case of persons of small intellectual ability, disastrous. The child is told to spell a word, and then expected to pronounce it; as though the spelling were a guide to the pronunciation. I remember hearing a schoolfellow hesitate when he came to the word "business." Spell it! said the teacher. Be you ess eye n e ess,—double ess, replied the boy. Well! and what does that spell? asked the teacher. As he paused for a reply to this unanswerable question, he espied a larger boy doing something wrong, and looking sternly at him, uttered his name, in tones of reproof,—*Christopher Frazer!* The little fellow thought this was the pronunciation of his "be you ess eye, &c.," and meekly repeated, Christopher Frazer. We laughed,—and yet that jumble of the *names* of the letters sounds as much like Christopher Frazer as it does like business.

Even if it be not desirable to change the printed form of our language, for ordinary purposes in books and newspapers; it is extremely desirable that the

books for the first two or three years of school life should be in phonetic print. The saving of time thus effected for the child, if the Cincinnati phonotype be used, has been experimentally demonstrated to be more than a year; and with Leigh's type more than six months; but the saving of time, although very valuable as giving more opportunity for geometrical plays and puzzles, and for the examination of objects of natural history, is not worth so much, as the increased happiness of school life, the increased sense of truthfulness, the increased accuracy of ear, and spirit of general accuracy, produced by it. The objection, made by those who have not tried the experiment, of the difficulty of transition from phonotype to common print, is of no weight. The pupil who reads phonotype *fluently*, can in one fortnight, without appreciable labor, learn to read common print; as well as it is possible for any human being to do what cannot be done.

The child who learns to read in phonotype, will learn common orthography more rapidly, because he perceives more clearly its oddities and anomalies; and that fixes them on his memory. Experiments in Waltham upon many hundreds of pupils, continued through a series of six or seven years, showed that those who had learned phonotype, or even phonography, were better in spelling than other scholars. Bad spelling, indeed, usually arises from an attempt to spell phonetically with the common alphabet; so that we might say that the cause of bad spelling is that children are taught to spell. For this, and for

other reasons which I shall presently mention, I regard spelling books as mischievous; a hindrance, not a help to learning. A child accustomed to associate phonetic values only with a peculiar type, and knowing that the common spelling is traditional and anomalous, will not attempt to use the ordinary alphabet phonetically, and will thus avoid the most common source of errors. The use of a phonotype, or even pronouncing type, has also the advantage of giving unceasing instruction in accuracy of enunciation; and no other method has been so successful in removing from a school provincialisms, brogues, and vulgarities of pronunciation.

For fixing the orthography of words in the memory, no practice is more useful than constant reading, with frequent writing from dictation; but the latter adjunct cannot be employed at the earliest age. When we have a phonotype in ordinary use in our literature, the child will learn the current hand writing at the same time that he learns print; but with the present heterotypy (as it has been facetiously called,) we must be content to begin writing at the time of transition from phonotypy; when, of course, the progress in writing will be much slower than in reading.

These two fundamental arts do not receive in our ordinary schools their due attention. To read, to write and to cypher are the three most valuable accomplishments taught in our public schools, and should take precedence in importance over all the rest. Not that more time is to be given to them; too much time is given already; what is needed is more thought

and attention, good judgment and good taste. What Luther W. Mason has done with music in the Boston schools, can be done with these three humbler arts in every school. All art is imitative, it cannot be taught scientifically, but only by example. Precepts, directions, principles, are of value only to the student who is actually trying to imitate a model. To learn to cypher the child must see the teacher perform an arithmetical operation; and then repeat it himself, until it is familiar, and he can do it with ease; then, and not until then, is the time to explain to him the reasons for what he has done. To learn to read, and write, the child must hear the teacher read, and see the teacher write; and then himself go over the same sentence, with his pencil, and with his lips, until he reads it readily. It is idle to tell a little child to let his voice fall at a period, to stop long enough to count two at a semicolon, and so on. Let the teacher read the sentence in easy natural tones, in such wise as to bring out the meaning; and let the pupil repeat by ear.

Pains should be taken from the very beginning to cultivate pure and natural intonation; smooth and melodious sounds. This is as important in reading and speaking as it is in singing. And yet I have been for fifty years hearing school teachers teach their children directly the reverse; constantly saying, "speak up, let out your voice," and forcing the little things to shout, and scream, in harsh unnatural tones. Distinctness of articulation can be best gained by a careful drill on the phonic elements of the language,

particularly the consonants; and sufficient force must of course be given to make the reading audible. But a boy of eight or ten years should not be required to speak loud enough to be heard by a school of 150 scholars; nor should a child of any age be allowed to go on through a single line of his reading book, in a strained, unnatural voice. Few scholars of American schools, as far as my observation goes, are at present allowed to read in any other than strained tones.

Nothing but practice can give ease and facility in an art, and practice takes time. This is a second mode in which the spelling book is injurious, it takes up time which would be much more usefully occupied in reading. It is reading which actually does the work, with which the spelling book has usually been credited. When a scholar has learned to read with perfect facility, so that the printed page is just as instantly intelligible to him as spoken speech, (and indeed a good reader can take in words silently from a printed page more than thrice as fast as by the ear), then the forms of the whole words of the language are as familiar to him as the letters of the alphabet, and he cannot spell a word in any other way than that which the tyranny of lexicographers and proof-readers has fastened upon him. No student of Greek, or of Latin, or of a modern tongue, uses a spelling book in acquiring the new language; yet in precise proportion to his acquaintance with its literature, he can spell it. It is so with the vernacular; and all spelling books are hindrances to learning to spell, they take up time which ought to be occupied in

reading ; the method of learning what we, with curious perverseness, call English orthography.

The character of the books put into the child's hands is an important matter. By the modern method of using in schools text books written with profuse explanations, as if for scholars without a teacher, the time of the pupil is very largely occupied with reading his text books, and he gets little time for reading literature. The reading books in schools, which were formerly made by compilation of classic authors, are now too largely original compositions ; or compilations from inferior writers ; or when containing selections from classic writers, those selections are mangled and weakened. These inferior books are read again and again by the scholar. When at home, many children have, at the present day, a superabundance of books, written for children, and not always by authors of the highest merit. There is danger therefore, real and imminent, lest our children fail to enjoy the best results of modern thought ; and fail to acquire the capacity for the enjoyment ; by enjoyment I, of course, do not refer simply to the pleasure received from art and literature ; but also to the power of using them in any and every direction.

A plan which was tried in Waltham, to obviate these evils, succeded so well that it deserves to be more widely adopted. First selecting the briefest and most condensed books in mathematics and the sciences, (and producing thereby better results in those branches also,) we next provided, at the expense of the town, classic authors as reading books, only

lending them to the scholars while in actual use. The books were kept in good order, and lasted for many successive classes, and we were enabled to give the children a greater variety than usual. For the younger scholars we had, for example, Mrs. Barbauld's Hymns in prose, and Maria Edgeworth's Early Lessons, while in the High School we had Shakspeare, and other standard writers, English and American; introducing some books of a scientific character, like Guyot's Earth and Man.

The approach to ordinary orthograpy through phonetic type, (and no other approach ought to be permitted) will very naturally lead to questions of etymology: which will interest a child several years before he is old enough to have any power to understand the analysis of sentences, or any form of syntax. Words themselves must be understood before they can be intelligently classified. When a word is introduced to a child in its orthographic dress; and he laughs, as well he may, at the oddity of this costume; we may tell him of its gradual growth into its present form; children's and foreigners' mispronunciations will illustrate to a young pupil the way in which words may change; and we can show him how the silent and mispronounced letters in a word are a record of its ancient pronunciation, or of its derivation, or of an ancient error in regard to its supposed derivation. This will lead us to explain to him the conventional element in language; that usage is the law and rule in speech; and to define to him usage as the usage of a majority of the best educated; and to

show him in what instances a usage creeping in ought to be strenuously resisted by the educated classes. When a geographical name, for example, is on all the maps and charts, it is an offence against morality, akin to removing a neighbors landmark, to attempt to change it. Holmes' Hole, Roxbury, Bangs Island, Pequawket Mountain, are geographical names on all maps and charts until after 1850, which ought not to be given up in favor of the much inferior substitutes recently invented, Vineyard Haven, Boston Highlands, Cushing's Island, Kiarsarge Mountain. To the last there is a third objection, namely, that it sounds so much like Kearsarge that it has already produced great confusion as to the identity of two mountains, fifty miles apart.

We may then go further back with our pupil, and show him that a part of our language is, in its origin, a natural attempt to represent the thing of which we speak. We may show him how a sound has, in a number of words, the same meaning; the compound element *sn*, for example, imitates a sneeze and seems to call attention to the nose, (in which word the elements are inverted); and the nasal element can frequently be detected in words containing this sound. The younger classes can see that the word nose can easily be introduced into the definition of such words as sneeze, snore, snarl, sneer, snicker, sniff, snivel, snort, snooze, snout, snub, snuff, snuffle; and even of such as snail, snake, snap, snare, sneak, snipe. The older classes can see how frequently an initial *th* points the forefinger; it is demonstrative,—as in this, that,

these, those, then, there, thither, thence, thus, thou; while the initial *wh* is relative, that is, it is a *th* preceded by a conjunction; and can be translated by *and th* or *and h*. Thus: "I saw a man who, etc.," is equivalent to "I saw a man and he." A similar force is in what, when, where, whence, which, whither, etc. Still older classes will be interested to see that the relative is an interrogative; a question always implying a previous thinking, with which the conjunctive part of the relative connects the demonstrative part. Such plums out of the pudding of grammar, will awaken, in some pupils, a taste for this fascinating study.

The forms of even the individual letters may be made the occasion of incidental instruction upon the origin of written languages; the probable development of Semitic alphabets from phonetic hieroglyphics; and of the European alphabets from those of Phenicia. If such instructions fail to awaken a scholarly turn of mind, and to lead to literary taste, they will at least relieve the dryness of learning to spell, and give the learner some glimpses of the numerous and subtle ties which bind us to all the generations which have preceded us.

The study of grammar, and of composition, does not belong to an early period in education. Grammar is the study of a maturer mind, and may be wisely deferred to the high school; or at least to the last year of the grammar school. It is an analysis of the usages of language, and requires the pupil to have become familiar with those usages.

It is also an inversion of the true order of educa-

tion to give a child an abstract theme to write upon, before he is old enough to think upon such themes of his own accord. In like manner, it is not in the true course of nature to set a child to declaim before he has any ambition or desire to speak for himself, his own thoughts.

The most instructive reading, for a person of any age, old or young, is that in which the author's tone of thought is above the average tone of the reader's thought, and yet not beyond his grasp. The best exercise for a child is to commit to memory, to repeat, but not to declaim, such selections, of poetry or prose, as, although not altogether above his comprehension, are worth being treasured forever in remembrance. As a general rule the child should be even discouraged from committing to memory anything except passages from the Scriptures, and passages of sterling poetry. The Scriptures he may commit to memory ; not only for their intrinsic value, but because they are often appealed to as authority, and when so used should be quoted with verbal accuracy. Good poetry may be also committed to memory, because a part of its value lies in its felicitous choice of expressions, and in the melody of its rhythm ; and these are lost unless it is quoted, or recalled to memory, in the poet's own language. But the committing to memory of the words of ordinary text-books, or of inferior poetry, or of school dialogues for exhibition, should be indulged only at the rarest intervals ; and the teacher who requires it frequently does a harm to the pupil far greater than he imagines.

The best exercise in composition is to read good authors; that is the only real "Aid to Composition." All art is imitative, and the great essential in teaching it is to set good models before the pupil. When the pupil has read something which is worth reading, let him close the book, and tell what he has been reading about. When he is old enough to write legibly, let him write upon his slate some brief anecdote from memory, after reading it. Let him with a ballad before him, tell the tale in good prose;—let him write in prose the ideas of a piece of poetry lying before him. The student who is old enough to write upon a given theme, will find after reading or reflecting upon his subject, no preparation for writing upon it, so effective as reading, for an hour immediately before taking up his pen, some particularly well written essays upon similar themes. It is in this way that an inferior poet can write sometimes an admirable parody, or imitation, of a superior one; by reading Shakspere, or Milton, or Tennyson, for an hour or two, he is able to write a poem of his own in the style of the selected author. Indeed, it is thus that all oratory and poetry, even among the princes of literature, has grown; each building upon, and stimulated by, the labor of his predecessors. And it is for this reason, as well as others, that it is so important that the child should have before him in the books which he reads at home, and in schools, the best models of pure English and of elevating thought; to give him the ability to express himself gracefully, that is to say, with ease and strength.

The French and German languages, and also Latin and Greek are taught in many schools in this country. Of late years there has been some return to rational methods in teaching languages; and yet the mania for educational drill prevails, even now, to such an extent, that I may be pardoned for speaking freely upon it. Twenty years ago the fashionable mode of learning a language was to begin by committing some text book upon its grammar to memory. In the case of Latin this grammar involved the grammar of the whole literature from the oldest writers, to the most recent; in Greek it involved all the various dialects of the different countries, as well as the changes in the more recent forms, from the more ancient. After this feat of memory, the pupil began to study very critically some author, pausing over each sentence and word to apply his grammar to the explanation of the construction. Finally, if his life and his patience, were long enough, he began to read the literature of the language.

The more natural method is more agreeable, and more rapid in producing results. The pupil begins by reading the literature, then analysing the language, and studying its grammar. The pronunciation is first to be determined; if Greek or Latin, some fixed principles must be adopted; if a modern language, we should get as nearly as possible the actual present usage of the best speakers. This is to be gained by the ear, listening to native speakers; although great aid may be had I hope in the not distant future from Bell's Visible Speech. While

learning to pronounce, you also are to learn to translate ; and the first essay is to be upon a sentence, not merely upon a word. Professor Sauveur's method in teaching French conversation is a perfect method of nature. But if you have not the living teacher, and are obliged to use books, begin at once with classic authors and translate them, without grammar or dictionary. The object at first is to learn the language ; to get if you can the meaning of the particular page before you, not for its own sake, but for the sake of learning the meaning of the words. Now, the meaning of the frequently occurring words will be fixed in the memory more surely by repetition of them, in reading, than by looking them out in the dictionary. Skip, therefore, the words and sentences whose meaning is not clear to you after a moment's thought ; read the chapter through a second time, and it may come to you. Your clew to the meaning is to be found in the similarity of the words to the cognate words in the vernacular ; and this method, therefore, can be wholly adopted only in the case of the modern tongues of Western Europe. If the reader of this chapter has never tried it, he will be astonished to find how readily an intelligent American boy, knowing only English, will pick out a part of the meaning of a page in French, German, Danish, Swedish, Italian, Spanish or Portuguese, and how rapidly, if he continues the trial always on the same language, half-an-hour every day, the proportion of the page which is intelligible to him will increase.

When the pupil can thus read the language, and

understand nearly the whole of what he reads, he may begin to look out in the dictionary the meaning of the few words which he does not know ; and then, also, he must begin to study the grammar ; after which as a final thing he may begin to translate from the vernacular into the foreign tongue, and to write in it original compositions. But this should not be done until the scholar can easily read and understand the new language without a conscious translation of it into the vernacular. This, however, is to be obtained by keeping up, even after beginning to study critically with grammar and dictionary, the habit of *daily* taking up, also, books which you are not studying, and *reading* them.

There are two entirely distinct objects to be kept in view while studying a foreign tongue ; the acquisition of a new language, and increased mastery over your own. For the first end, you need to pay close attention to the minutest details of the construction and order of the words of the author whom you are reading ; for the second, to express his thoughts (occasionally, at least, and in his finest passages), in the best and most idiomatic English. When reading Plato, Cicero, Goethe, or Molière, you wish to seize their thoughts precisely as they uttered them, with the words in their very order, and with a perception of the ideas direct from their words, without even a mental translation into your own tongue. This power is acquired by the combination of the critical study of some one or two select works with a rapid, extensive reading of the other writings of your author.

In this reading for the sake of learning the new language, the translation, if one occurs to your mind, will be slavishly literal, and if you should utter it would be less intelligible than the original ; like Thomas Taylor's translation of the Divine Dialogues, in which he follows the author so literally, that the English is harder, for an Englishman, than the Greek. But if you would have the study aid you in expressing your own thoughts, you must also at times accustom yourself to translate, from the original, the thoughts alone ; putting them, with fidelity to the thought, into English entirely remote from the forms of your author, and peculiar to our own best writers.

These directions are not inapplicable to schools. In the Waltham High School we had for several years a teacher whose classes would bear the most vigorous examination in all the niceties of philological and grammatical analysis, and would also read, from a Latin or French author, so fluently and in such easy and idiomatic English, that, as a member of the examining committee, I not unfrequently felt obliged to inform visitors that the class were not reading from a written or printed translation. The teacher should require, in a spoken or written translation, one thing or the other, either extreme literal accuracy, or else good idiomatic English. Next to the ability to act well, must be placed the ability to speak well ; indeed, so interwoven are the functions of the human being, that the ability to express thought increases the ability to think ; and the power to think increases the power to act.

That which pertains most strictly to the general purpose of the little volume, however, is to lay emphasis upon the fact that in the order of nature a child hears music and spoken language long before it has the power to study and analyse them. Whatever language we are considering, it is better for the child to be taught to read and understand it in its larger scope and meaning before he begins to give it a critical and thorough study. He must learn to sing and play, before he is ready for thorough bass and counterpoint. He must read and write English, before he is ready for grammar and rhetoric. He must in like manner be able at least to read easily any other tongue before he takes up its grammar. And in learning to speak and write it, he must confine himself to the best models of native writers and speakers until he is perfectly familiar with them; before he begins himself to use it in expressing his thoughts.

CHAPTER XVI.

LAW.

THE word law as used in the title of this Chapter has a wide significance, including the whole history of the state ; of both the military and civil powers; the mode in which human society has been governed, or endeavored to govern itself in all ages.

The child is born subject to his parents ; and the parental government has always been a type ; perhaps suggesting and leading to the government of tribes and nations. At all events, there are no savages to be found without some traces of government ; and in all civilized countries, there has been developed the idea of impersonal law; through the organization of a community whose associated wisdom shall decide upon what is right, and what is for the best interests of the whole ; whose associated power shall enforce the right, and develop the good, so far as the limits of its ability extend. The historical study of these relations of men to each other is necessary, not only to the full development of the student's mental powers ; but as a preparation by which he is fitted for an intelligent participation in the rights and duties of those relations; which is by definition the chief end of a liberal education.

The method of nature, in this branch of discipline, is sufficiently obvious. The child is born into a family, and is subject to his parents; they require of him obedience before he can understand the ground on which the authority rests. No disciplinarian of the modern school has as yet, I believe, published a text book for infants, explaining and proving to them, while yet in the nurse's arms, the logical foundations on which they are required to submit to and obey their parents. Here is one retreat, where nature and common sense retain some hold. In a well ordered family the child learns by subjection to his parents, the duty of subjection to just authority, and forms a habit of obedience. He is brought under the order and discipline of the family, before he can rise to the perception of that vast scheme of universal order, planned by Infinite wisdom, in obedience to an impulse of unfathomable love, and carried into execution by Almighty Power;—that Universal Order, after which all wise legislation strives; according to which all just judicial decisions are framed; and which all righteous executive power seeks to embody.

Thus also in the school. The first and most important ideas of law, gained there, come not from histories and constitutions, political essays or orations; but from the wise and just discipline of the school room; from the rules of play observed in the games of the school children; and from the perception that the parents and teachers are also the subject, even in school matters, to the regulations of the committee, the votes of the town, and the laws of the common-

wealth. The judicious teacher, by occasional words, rightly directing the child's attention, for a moment, to such themes, giving an incidental instruction in politics and law, does an important work for the State, and for her children.

Under this department comes also History in the ordinary sense of the word. The "History of the World" is too vast a field for survey as a mere part of liberal education. In selecting nations and periods which shall be most useful to the general student, it is manifest that we should confine ourselves, principally, to the direct line of spiritual inheritance, the sources whence we derived our science and laws. The United States, particularly in the periods when the Colonies were taking consolidated form, and when they were achieving their independence, and becoming a nation: Great Britain, especially in the sixteenth and seventeenth centuries; Rome in the age of Cæsar and Augustus; Greece just before, and during the age of Pericles; and Israel from the days of Moses to those of Solomon; these are topics on which every man, who takes any interest in the welfare of our dear land, ought to be early well informed. They all bear directly upon the questions of to-day in a Republican Government. Before the young man leaves the High School he should also take a brief course of study in constitutional law; comparing the constitutions of our States, and of the United States, with those of Great Britain, Rome, Greece, and the early Hebrew Commonwealth. The simplicity of our constitution brings this study within the reach of all minds; and the im-

portance to the nation of having the knowledge of the constitution diffused among the people makes it an imperative duty for every High School graduate to have read carefully some simple and sound commentary upon it.

CHAPTER XVII.

POLITICAL ECONOMY.

BESIDES the government of man by man, the older pupil will see that men's affairs are also governed by laws not altogether under their control. He will find at one time the community apparently prosperous, and after a year or two will hear that business is dull. He will hear allusions made to the time when gold and silver coin were used freely, as the fractional paper currency is to-day. At the time when elections for Congress are about to take place he will hear earnest debates concerning the currency, or concerning protection and free trade.

It is not well that the young man in the public school should have angry political passions aroused ; or become a partisan upon either side, blinded to all consideration of truth as held by his opponents. But there are fundamental truths, established by the clear thought of Adam Smith, and Henry C. Carey (the two most solid thinkers upon these subjects), which are valuable to every citizen ; and no sound decision concerning such debatable questions can, except accidentally, be reached by one who does not learn these truths. Some of these vital propositions are perfectly within the comprehension of children, and ought to be

taught in the public schools, as a protection against multiform errors introduced by English writers, and popularized in tales and newspapers of the present day.

The government of man by men is, of course, liable to error; mistaken legislation and arbitrary acts of military and executive power, may therefore occasionally interfere with the operation of the natural and wholesome laws of commerce. Persons living in countries in which the course of legislation, and of custom, has long been in an erroneous direction, will be likely to mistake, and misunderstand, the natural laws; and this, as we Americans think, is the condition of persons living in Great Britain, where laws of primogeniture, entailment of estates, difficulties in conveyancing, guilds and trades unions, so utterly prevent freedom of trade in the two prime raw materials, land and labor, as absolutely to prevent an Englishman from knowing what freedom means. We draw from our fatherland a rich inheritance of political and civil freedom; but we also draw, at the present day, many false opinions in specious dress. The firmness with which an Englishman adheres to a theory, or to a custom, or to a supposed right, is an excellent element in his character, making the progress of the nation stable; but it is an inconvenient element, when he gets started in a wrong direction.

The youngest child may be taught how to place a just estimate upon the worth of things; that a thing is useful in proportion as it gratifies, or enables you to gratify, healthy human desires; and thus promote

human happiness. Thus an article which can be used for an indefinite time, and by a multitude of persons, (for example, a book, a picture, a statue), is worth incomparably more than a thing which is used but once, and that only by a single person ; even if the price in money be the same. The usefulness of a thing is its ability to serve human needs, and may exist in the highest degree in things like air and sunshine that are generally without price. Price is the measure, in gold or silver, of the commercial value. Value is the measure of the difficulty of reproducing a useful thing. Wealth consists in the ability to command the services of natural agents. The whole life of a civilized community depends upon commerce ; upon the interchange of men's services, by which each does something that others desire him to do, and receives from them in return what he desires. The instrument by which this is accomplished is coin. The persons through whom the commerce is effected are tradesmen, or merchants, and common carriers. The fewer of these, and the nearer that producers and consumers are brought together, the more advantageous is the commerce. No country on earth is, or probably ever will be, over populated ; and the poverty, vice, and crime of nations ; their decay ; and the depopulation of countries, arises from misgovernment, tyranny legislation to encourage foreign trade ; and other errors of men. Such truths as these, and others equally valuable, may be incidentally presented, and illustrated by occurrences in the course of the school life, or by passages in the school histories ; and will

enlarge the minds of the young men, and prevent their being afterwards ensnared by the sophisms of those who still re-echo Ricardo and Malthus, or still hold that foreign trade is more important than internal commerce.

CHAPTER XVIII.

PSYCHOLOGY.

A CHILD of six years old recently asked "How do you know that any thing is there, where you see it?" The question seemed to indicate precocious metaphysical development; and there can be no question that a precocious metaphysical spirit of psychological introversion, is as much to be deprecated, as the premature study of physiology. But the anecdote shows that such questions arise at a very early age, and the judicious teacher may find some better way of quieting the doubts and conflicts than by absolute silence, or by laughing. Children suffer very much from dreams, and from waking visions in the dark; especially if they have been unfortunate enough to hear or read stories of elves, witches, ghosts, dragons, and the like. They are afraid to speak of the matter, and endure the agony in silence. Many an otherwise sunny childhood has been clouded by these visions; the child being haunted at night by a fear that the vision was, after all, a finer reality; or, like the boy whom I have mentioned, that the realities of the day were as unsubstantial as the visions of the night. "Mother," said another child, on awaking, "I thought that this world was God's

dream." I could give many anecdotes to a like import. And some children still retain the faith which men formerly held, that dreams are visitations by night, of spiritual beings. Even at the present day there are men who hold that view.

It has seemed to me that, in consideration of the great suffering of childhood from that which Hamlet so much dreaded, bad dreams, we might, quite early, give the child enough of psychology to explain to him the harmlessness of these monsters. He knows, before he goes to school, that there are brains in his skull. He might upon some incidental opportunity be told that when he is thinking, he is moving his brain, as truly as that when walking he is moving his legs. And that as sitting still is resting the legs, so stopping all thinking, which is sleeping, is resting the brain. Then he may have observed in himself, or in a very tired dog, on dropping asleep, a twitching of the legs ; so in a very tired brain, there is a twitching, a motion ; and that partially arouses it, and sets it to half conscious imaginations, which are dreams or visions ; they are his own fancies and imaginations when he is so nearly asleep, that he does not know they are his ; but they cannot really hurt him, any more than his playful make believes when awake.

This explanation will still leave certain points concerning dreams as great a mystery as ever ; they may be, as Emerson has pronounced them, an inexplicable one ; but this partial explanation, not carrying the child into much introversion, may yet enable him to bear with more composure this annoying symptom of

fatigue, of over excitement, of too heavy a supper, or, still more frequently, of a slight cold disturbing the digestion.

Truly metaphysical inquiries belong to so late a period of the course of education that I do not care to speak of them in this book, which is principally taken up with the studies of the younger pupils.

CHAPTER XIX.

AESTHETICS.

THE perception of beauty shows itself at an early age. I have known a child whose first articulate word was the exclamation "pretty!" on seeing a bright nosegay. The analysis of beauty, as the embodiment of a simple law in a variety of details, is the work of a mature mind. Erasmus Darwin attributes the sense of beauty to the association of the ideas of the pleasures of satiety in the infant, with the curved outlines and soft contour of the mother's breast.

This theory would deprive the infant brought up by hand, of all appreciation of beauty; therefore the modern followers of that eccentric philosopher, supply an inheritance of instinctive ideas derived from grandparents who were more fortunate in their infancy. This discussion of the nature of the sense of beauty is not required for education; but the culture of that sense is requisite; and if the child's taste is properly cultivated, and he have native delicacy of perceptions, and depth of feeling, he will when old enough to think for himself give a very different account of the origin and nature of the perception of beauty. He will discover then that the sense of beauty is awakened only by those objects which show

a thought, simple in itself, embodied in variety of detail; so that it is an intellectual pleasure in the presence of a work of intellect.

To cultivate the taste for beauty, care should be taken in the furnishing of the school house, the hanging of its walls; and if it be a country school-house, in the arrangement of its grounds. Of two text books, in other respects equal, that is to be preferred which has a well proportioned page, and that in which the illustrations are well drawn. In the selection of copies, whether drawn or natural objects, choose those which are of normal and beautiful forms. If you have chromos, or paintings, on your walls, let them be not only beautiful scenes, but well and harmoniously colored.

Fröbel's gifts are arranged with reference to color as well as form. I have for twenty-five years past been accustomed to try direct experiments on the beauty of form and color as perceived by scholars. For example I place a long rectangle in sight, (say of stiff paper tacked on the blackboard) and covering one end, (say by a slate without a frame) I shorten the rectangle, and ask the pupil to decide at what length it is of best proportions. In the judgment of seven out of ten, the best proportion is that in which the diagonal divides the right angle in the ratio of very small integral numbers. To give another example, I have taken two circles of card of equal size, and drawn in each a central circle of just half the area. In one I paint the central circle purple, the outer ring yellow; in the other, the centre yellow, the outer part purple;

being careful to use precisely the same shades on each card. I ask the pupil to compare the effect on his feelings produced by looking at the one, and at the other. Nearly every child will, without knowing what others have said before him, say that the one is constrained, sad, depressing, autumnal; the other free, cheery, summer-like.

A series of experiments of this kind awakens in the pupils a new interest in the beauty of nature and of art, and rapidly cultivates and improves the taste. Of course this is merely rudimental, and not to be considered as taking the place of the higher art culture which should follow in those who have the taste and the means. At every step in the course of drawing lessons, a judicious teacher may by skilful questions or suggestions lead the pupil to a keener appreciation of the beauty of form. But let the criticism be always guided to the perception of beauties, not to the exaggeration of defects.

The lessons in singing give also constant opportunities for æsthetic reading. First in regard to mere purity and smoothness of tone; it should be remembered that there is a beauty in the mere quality of a monotone, just as there is beauty in mere purity of color; and this is not a matter of whim or association of ideas; but, both in sound and color, arises from what may be called an unconscious perception of the rhythmical character of the motion. The greatest pains should be taken to check all loudness, harshness, roughness: natural smoothness in the early attempt to sing being much more important than

correctness of integrity or of harmony Secondly, pains should be taken to have the melodies and the words adapted to each other, and that both are good. The Music Readers for the Boston Schools are commendable in this respect, as are also many of the older collections of Church music. But there is also a style of music and of hymns popular in the churches and Sunday Schools to-day, to which I have already alluded, as having a debasing, demoralizing effect. The words are vapid, or strained, not in idiomatic English; and the music is of the same character, a mere haphazard writing of the notes, and subsequent division into measures. We have in these instances neither English melody nor German harmony; but a composition which has been well described as having the flavor of boiled water.*

I have found it advantageous to ask pupils to give their opinion on the meaning of a melody, new to them, and of which they knew nothing, except as they heard it for the first time upon a piano; and I have

* Lest I seem to strike in the dark, let me quote, first an entire chorus from a popular hymn to the Saviour:—"Ever near us, guide and cheer us, Touch our eyes that we can see; If thou charm us, naught can harm us, Still the Father calls through thee." The meaning of the word "charm" in this chorus, and the connection of the fourth line with the other three, passes my comprehension; as does the following popular illustration of the aphorism that "Bright things can never die": "Many a happy thing, Many a daisy spring, Float o'er time's ceaseless wing, Far, far away." May such poetry keep far away from me and mine. What a contrast between these two stanzas and the songs of Watts, or Mrs. Follen.

heard of a good teacher, who always required her pupils thus to judge of a piece, before they heard its name, or attempted to play, or sing it. Every melody has an expression of its own, heightened and modified, but not essentially altered, by harmony, and by orchestration. The melody thus answers to outline, harmony to light and shade, orchestration to coloring. Bring into the school frequently the portraits, photographed, engraved, or lithographed, of various persons of marked character known to you; and let the scholars without hint or clew, tell you how the face impresses them. They will doubtless surprise you by the accuracy with which they will often describe the real character of the person. In the same way, sing or play to them music of good character, written by composers of merit, for specific words or specific occasions, and let the pupils, without hint or clew, tell you how the music sounds to them,—what feeling it expresses, or for what occasion it seems adapted. This will increase very much their appreciation of music, and its usefulness to them.

I have spoken of the use of classics as reading books; Mrs. Barbauld and Miss Edgeworth for younger scholars; Shakspeare and Wordsworth for older classes. If you have not this privilege, but must use the ordinary collections, let the class read two pieces of very unequal literary merit, and then call upon them, without hint of your own opinion, to give their judgment as to the respective style and finish of the two pieces. After they have given their opinion, give them the benefit of yours.

CHAPTER XX.

ETHICS.

AS we approach the higher branches of the hierarchy we come as I remarked concerning Political Economy, to disputed questions ; and are to be careful not to arouse partisan feelings, nor to give doubtful opinions for settled truths. There are various theories as to the logical foundation of ethics, but the discussion of those theories is to come only in an advanced stage.

At the child's entrance into school he has learned the meaning of the words "you must," and "you ought." He has a dim sense of the difference between a mistake and a sin, between want of taste and want of principle. The teacher who begins to reason with him at once, and explain to him the fundamental theories of ethics, will probably do him harm, and make him doubt the reality of ethical distinctions. The natural mode of procedure is to deepen, first of all, as far as you are able, his sense of obligation, of duty. Let him see that you feel it binding upon you ; and that nothing earthly, or unearthly, could tempt you to do what you are clearly convinced is wrong. Feelings and sentiments are contagious ; the character of the teacher is, in spite of himself, reflected in

some degree in the character of his pupils. I once asked a teacher, who succeeded, incomparably better than any other teacher I ever knew, in keeping the clothes and faces of her pupils clean, the school-house and outbuildings perfectly undefaced, how she did it. "I don't know, Mr. Hill," was her honest answer, "*I do not try to do it.*" Then, after a pause, she added, modestly, "there is perhaps one thing, I am always scrupulously neat myself." That was doubtless the secret; her own person, her dress, her desk, and table, her books, were always perfectly clean and in perfect order.

Thus also the teacher who has himself seen the awful sanctity of the moral law, and felt that in spite of all which utilitarians and sensationalists may say, a man had better die, and be annihilated, than deliberately to do what he clearly knows to be wrong, he will without lectures, sermons, or twaddle, impart to his pupils the same sentiment. If you would know the reality and cursedness of sin, the nobility and glory of virtue, said my Latin tutor to me, read the "Agricola," of Tacitus. You can see it in the lives of men, you cannot learn it from their lips.

Mary Wolstonecraft carried out that idea in her "Elements of Morality"; which was a series of portraitures of vices and of virtues, woven into a story of Mr. Jones, a merchant in Bristol. The same thing was well done for American schools by M. F. Cowdrey, of Sandusky, Ohio; his anecdotes were not, however, interwoven in a story. The fascination of the modern novel and tale is in the portraiture of characters which

they present, "holding the mirror up to nature"; and if it is truthfully done, giving the hideous aspects of sin, and the attractive side of goodness, it is a good work. A novel is thus a potent agency, for good, or for evil. The same may be said, in its degree, of the little stories which are told in a child's hearing, or embodied in the books which it reads. Good morals and good manners come first of all in the objects to be sought in the public schools, but they are most successfully taught by the teacher taking the greatest pains first to be irreproachable himself. The art of living well, like other arts, is learned by imitation of a good model; and a living object is the best model in all cases,—if accessible.

CHAPTER XXI.

THEOLOGY.

IT is difficult to separate morality from religion; even the idolatrous, and semi-atheistic Chinaman sanctions his moral precepts by religious doctrines; and a Chinaman who had thrown off his idolatry, and for a time rested in pure atheism, told me that he felt during that time no moral restraint; and that his sense of duty and obligation did not return, until two or three years afterwards, when he was converted, by the simple sublimity of the first chapter of Genesis, to a faith in Theism, and then to Christianity.

Debates have arisen in America within a few years concerning the use of the Bible in schools; concerning the introduction of the idea of God into the public teaching; concerning the separation of the public school funds and the payment of a part of the income to the support of Church-schools. The second of these questions alone comes within the direct scope of this volume; but I am not unwilling to record my opinion upon the other two.

It seems to me that public education is a necessity in a republican government; that the expenses thereof should be met by a tax levied upon all; and that the proceeds of that tax should be expended only in

the support of schools entirely within the control and management of persons elected by the public vote.

It seems to me that while the reading of the Bible is not a necessity in public education, it is highly fit and proper that a portion of that book should be daily used liturgically in the public schools of a Christian community. The selections from the Bible by Joseph T. Buckingham were used in Waltham, with happy effect; the selections by the Rev. D. G. Haskins seem to me admirably made for school purposes. Our rule in Waltham was that no child should be compelled to read, if his parents objected, and we even allowed those children, whose parents wished it, to enter school *after* the morning reading. The promulgation of this vote put an immediate stop to all complaints; and no parents ever availed themselves of the privilege. "Sat erat potuisse videri." If my memory serves me, the same thing took place at Antioch College; a parent objected to his son being obliged to attend morning prayers. "If I had wanted him to study theology." he wrote, "I could have done it cheaper at Oberlin." I replied, that the young man was not obliged to attend prayers, if either he, or his father had conscientious scruples. That closed the matter; and the young man attended, when he found that he was not under constraint.

But in regard to the third question, the exclusion of Theistic teaching, the case is different. We have among us conscientious persons who demand the entire secularization of the schools; they would exclude sectarianism by excluding Religion. I cannot

but regard this as a fundamentally erroneous position, founded on radically defective postulates.

The education which the safety of the republic demands, for every one of its children, is a liberal education; that is, an education becoming a freeman; an education fitting one for the duties of a citizen. First of all, in the requisites of such an education, it must impress upon the future citizen the inviolable sanctity of law, the reality and eternal worth of justice, the necessity of maintaining the rights of others as well as your own. Now in my opinion, and in the opinion of a vast majority of intelligent men, this cannot be done, unless the child be led to recognize reverently the being of God, the all seeing Witness and Judge, as the first and greatest of all truths; the widest and most firmly established of all inductions; the clearest and most certain of all intuitions. Herbert Spencer, who is considered by most of his readers as an anti-theistic writer, declares the being of an Ultimate cause of the universe, to be avouched to us by a strength of evidence, greater than that for any other truth; so that we are more sure of the existence of such a cause, than we are of our own. Moreover the same writer declares that there is no vice in the constitution of things, but that every thing moves forward towards better ends for the human race Thus the leading opponent, in England, of theistic views, virtually acknowledges that the existenee of a wise and beneficent origin and cause of the universe is the most certain, and most comprehensive of all truths. It is, I maintain, the simplest wisdom to give

to this grandest and most certain of truths, a single word, or name; that is to teach the child to refer all the wondrous harmonies of the universe, and its beneficent laws of operation to God; to teach him to regard God as ever present, ever a witness even to his thoughts, and ever being so wise, and so just, and so merciful, that he will make it turn out well in the end for those who adhere to the law of right, evil for those who persist in doing evil. The child will, of course, attach crude and false conceptions to this great name. But they will be incomparably less crude, and less false, than those which he will form for himself, if untaught. The superstition of a child brought up religiously may be lamentable, but that of a child brought up atheistically is horrible.

The existence of sectarian disputes about religion, and of partisan contests in politics, no more forbids the introduction of religion, political economy, and constitutional law, into schools, than the existence of scientific differences of opinion forbids the introduction of science into schools.

Some believe that geometry deals with space, and the ratio of circumference to diameter is about that of 22 to 7; others believe that geometry deals with dimensions, and that the ratio is that of 3 to 1; some think it best, in subtraction, when the subtrahend figure is smaller, to add ten mentally, first to the minuend, then to the subtrahend; others prefer to transpose mentally one of the tens in the minuend. In spite of these differences of opinion, geometry and arithmetic continue to be the foundation of all human

learning and necessarily occupy the earliest place in our course of education. The same may be said (m. m.) of every branch of science. And above all, unless political economy, constitutional law, ethics, and theology, crown the education of the young man, then the whole course of his culture, so far as regards the interests of the state and of the community, which has borne the cost of his education, is concerned, is worthless; it has stopped short of the point for which all the course is established. The Westminster Assembly's first question, and answer, agree with the saying of St. Paul, concerning the Creator, that of Him, and Him, and for Him, are all things; not a step can be rightly taken but in explicit, or implicit, obedience to that truth. The test of scientific theories is their conformity to the Creative thought. In generality, comprehensiveness, distinctness, and brevity of statement Kepler's laws are equal to Newton's; and the great advantage of the latter is found in their intellectual simplicity, and therefore presumed nearer accordance with the way in which the Divine Mind sees the planetary motion. The test of ethical and political theories is their conformity to the will of God. The ethical judgments are drawn with such instinctive rapidity that we are unconscious of their bases. But when the reflective age comes, and the young man begins to question why this action should be wrong, and that right; it will be a great danger to his integrity and virtue, if he has no faith in the being of One all-seeing, all-holy, just, and righteous Judge, guiding and controlling the destinies of men.

And, as a merely intellectual idea, there is no other fitting end of the study of the lower branches of the hierarchy than the recognition of the wisdom and goodness of the Creator. Those modern European writers who think that Theism is an inferior system to Pantheism, because it is the system of the Semitic races, who are inferior to the Japhetic, are as mistaken in their intellectual conceptions of science, as in their prejudice of race. Physical science is the unfolding of the harmony of the creative thoughts; and Mathematical Science derives its value from its furnishing means by which we demonstrate that harmony.

I have been acquainted with two distinguished teachers, who conscientiously abstained from giving to their pupils their own opinions concerning religion; they seemed, in regard to theology, to value freedom above truth; and would rather have their pupils fall into error, than to exert the slightest influence over them, to bias them. It seemed to me a mistaken course, and I think that in both cases, it had a disastrous effect on the pupils. Irreligious and sceptical men, and sceptically inclined young people, will interpret such silence as disbelief in religion; and the teacher does thus bias the minds of some of his pupils towards unbelief. I respect a man who earnestly fights the principles of Newton as erroneous, more than I can one who evades your questions, and tells you that he does not wish to say whether he believes or disbelieves the results of science. I should prefer an outspoken atheistic, materialistic opponent to Christianity, if I thought him

really honest, to a man who was unwilling to give up the name of Christian, but even more unwilling to let his pupils know his opinion concerning any point of natural theology, or of revealed religion, or of the evidences of Christianity.

CHAPTER XXII.

SCHOLIA.

THE teacher must not forget that the education of the knowing faculties, is a very imperfect and unimportant culture, unless we at the same time time impart the power of expression and of action, and awake sentiments and feelings worthy to be expressed or embodied. In this little volume we have been chiefly occupied in showing in what manner we conceive the circle of human sciences to be bound together in an ascending spire ; which is our best guide in choosing subjects for intellectual instruction. But the body also needs care ; the teacher and the parent should see to it, that the child has fresh air, of proper temperature : sufficient muscular exercise, and training of the muscles ; good and wholesome food, and abstinence from what is hurtful; sunshine and cheerful amusement. The heart needs training, and the teacher and the parent must ever by the example of reverence, kindness, good humor, patience, hopefulness, appreciation of the beautiful and the true, be cultivating right affections. Above all the will needs training, to prompt unhesitating action in obedience, first to rightful authority on earth ; then to the will of God, in heartfelt consecration to his service, and in

charity to men. The power of expression and action is to be cultivated in every direction, pursuing every scientific study, also, first of all as an art; both for its use as an art, and for the superiority of the mode of approaching it as a science.

And we believe that the sequence of intellectual studies which we have endeavored to show is conformed to the nature of things and to the nature of the growing mind, will give also the best opportunity for education in character and in executive ability. For example, we place first in the scale of studies, the cultivation of the powers of observation by the outward senses; before invention or reasoning. This intellectual order gives the opportunity, in the case of the child's body, for keeping him much out of doors, rambling under the guidance of its teacher; by the roadside, or over the pastures, to the benefit of its health, as much as of its mind. The same order gives in moral education, the opportunity for developing pure tastes, and a love of natural beauty; it affords, also, social pleasures of a higher character than the ordinary plays of the school-yard. It gives, furthermore, the best opportunity for impressing the young heart with a sense of the infinite wisdom and love manifested in the creation; while the freedom of the walk allows the child to manifest its character in its treatment of its schoolmates; and gives the skilful teacher opportunities to influence it to active kindness, thoughtfulness, and helpfulness.

The complaint, so urgently made by some, that an intellectual education is a moral injury rather than a

moral benefit, has been abundantly shown by statistics to be without adequate foundation. So far as it has any foundation, it is grounded chiefly upon facts arising out of the inverted order of our intellectual drill; teaching reasoning rather than observation; taking the child's attention from God's book of nature to fix it on books written by inferior men; making intellectual training so difficult and discouraging as to interfere with the time and strength and heart for moral training.

In like manner, the injury sometimes done to the bodily health of students, by over exertion of the brain, comes in no small degree, from the unnatural order of studies, giving the abstract before the concrete; by virtue of which the difficulties of each step are greatly increased; and it frequently becomes necessary for the student to master, in a hurried manner, in a few months, that which, under the natural order of studies, he would have acquired leisurely and pleasurably, years before. Whatever be the amount of knowledge acquired in a given time, the ease of its acquisition, and the ease with which it can be applied to use, will be partly proportional to the lucidness and naturalness of the order in which its parts were arranged and presented to the student. This purely intellectual questions, therefore, of the true order of studies is intimately connected, in more than one mode, with all questions that involve the highest welfare of the individual, and of the family, of the State and of the Church.

Whether I have made any contribution toward

settling the question in what order the studies of the curriculum ought to be placed, or not, the reader must judge. August Comte classified the branches of knowledge according to the degree of generality of their ideas, placing mathematics first, because the laws of form and number govern all matter in the solar system; and political economy last, because its laws govern only about one million tons of matter, in the form of human brains; psychology and theology he remanded to the realms of fable. Herbert Spencer denies that the sciences can be arranged in any one series; but arranges them in two or more, making the sequence in each series depend not upon the generality, but upon the abstractness of the ideas involved in the sciences. Thus he also places the mathematics first because they are, in his view, the most abstract. Other writers have classified the objects of study more or less thoroughly. But in whatever manner our philosophy leads us to classify the branches of human knowledge; and whether we do, or do not, see a universal order and arrangement such as I have given as the hierarchy of sciences; this one point I would press upon the reader as certainly true, and of great practical moment, viz.: that in a great many cases, notably in mathematics and physics, there is a natural order in which they should be taken up, and that the neglect of this order, so common in our schools and colleges, involves a great waste of the student's time and power, and cripples his usefulness in after life.

While all the studies of the curriculum must be

used as means of guiding and developing the power of action and expression, as well as of thought, it must especially be remembered that the historical studies, (trades, arts, language and law) are peculiarly adapted to this function; and the teacher must be careful to make them all conspire in giving the pupil freedom and power in utterance; by the lips, by the pen, by the fine arts, by right action. Intellectual thought finds utterance in words; sentiment in art; principle, in acts. Action strengthens principle, gives depth to sentiment, and clearness to the intellectual vision.

To recapitulate; I see the objects of human thought and knowledge arrange themselves in five great groups. Under the first come Space and Time, and the abstract idea of Number; concerning these, men build the sciences of Geometry, Arithmetic, Algebra, and higher mathematics. Under the second lies matter, the physical universe in all forms; concerning which we have sciences of mechanics, with its remote branches of acoustics, thermotics, optics, &c., chemistry, physiology, botany, zoology, geology, astronomy, &c. The third group is historical, and embraces all that man has said or done on this planet; his manufactures, commerce, agriculture, government, war, literature, fine arts, &c. The fourth group takes in the mental, and spiritual powers of man; and considers his capacity for thought, for passion and sentiment, and for actions what the powers are, and how limited and modified. The fifth group embraces all the attempts which man has made to rise to a knowledge of the ultimate causes of things, the origin of the

Universe, the mystery of the government of all the phenomena by noumena,—the reign of law, which law is thought.

These five great branches appear to be logically dependent in the order in which I have placed them; geometry being the foundation of learning; nor can we conceive a man gaining a knowledge of anything whatever, except geometry, until he has gained the corresponding foundations of his knowledge in each of the groups below, down until he reaches the knowledge of relations in space.

The order of the hierarchy is the logical order in which the sciences are developed one after the other, but it by no means follows that mathematics can be developed and followed to their highest summit without reference to any thing that succeeds. There is such a mutual inter-dependence that the lower branches are continually suggested by the higher; and in any one study, we not only require a competent knowledge of the lower branches, to enable us to stand where we are, but we must attempt to use our knowledge upon a higher branch, in order to receive any impulse, to rise higher in the one upon which we stand. Thus the mathematics were stimulated and enlarged by the attempt to apply them to mechanics and crystallography, and these again stimulated by the attempt to apply them to chemistry. Chemistry saw new fields when she sought to solve the problems of physiology; and thus on through the whole of the sacred circle.

For a full harmonious development of a child's

mind we must daily recur to the five essential branches of inquiry suggested by every sight of nature. The youngest child brings in, for example, a dandelion. Its circular form, its radiant lines, the number of its rays, the bell shape of the involucre, the cylindrical scape, and its cylindrical cavity, the close spiral into which the split end of the scape curls itself, these are mathematical points to which his attention may easily be directed. Its yellow color, slightly bitter taste, the use of its root in medicine, and in the adulteration and imitation of coffee, its relationship to asters, sunflowers, ox-eye daisies, fleabane, tansy, yarrow, ragweed,—these matters belong to the great group of natural history;—in some of them the youngest child can be interested, and in all of them the older ones. The derivation of the name, dandelion (dents de lion, dens leonis) from the form of the green leaf; and of the generic name, taraxacum, from its medical effects; the fact of its introduction from Europe; quotations from Lowell, and other poets, referring to it; these would be historical instructions naturally flowing from the incident of the dandelion being brought into the schoolroom. If now the child is asked why he likes the flower so much; whether it is because it is prettier than others; or whether because it comes so early in the Spring; or whether because it is so common, the poor man's flower, and the children's flower; the questions will stimulate a healthy psychological curiosity, not a morbid introversion, but held still to a healthy attitude by its external hold upon the flower.

And finally this little flower may give theological lessons of great value, if without parade or cant, but in a simple and natural manner, you allude as from your own fulness of heart, to the goodness of the Heavenly Father, in spreading beauty with so unsparing a hand; or simply bringing to the child's remembrance, by quotation, or by a child like paraphrase, the Saviour's appeal to our consciences, drawn from the lily of the field.

Now every lesson, in this school of life, will lead, as naturally as this dandelion has done, to the five great branches of intellectual studies; and no lesson has done its full work for our minds until it has been thus linked into relation with all the main lines of dependent truth. The simplest geometry has its application to physics; its history of discovery and application; its psychological questions of the foundations of belief, and the nature of proof; its theological aspect, in the query for example whether the relations of space are dependent on the nature of our minds, and thus upon the will of the Creator. The cycle of the five branches must thus be daily recurring, and my aim in these chapters has been to show in what order the five branches are to be placed; which must always precede, and which follow; which must always be in a higher state of development; and which, the crown and glory of the whole, must always lie least within the reach of our finite faculties.

The highest truths which man can possibly seek are those which directly pertain to the unlimited Power, the unfathomable Wisdom, the inexhaustible

Love, out of which the wondrous spectacle of the Universe, and we, as spectators and actors therein, ever flow ; the knowledge of these truths is Theology. The next subject in dignity and importance is the investigation of our own souls, whose thoughts and emotions, and holiest sentiments, we see prefigured and pre-embodied in nature ; and it is by that presence of a likeness within us to the creative energies, that we are able partly to comprehend the created universe. The study of the human mind, the greatest work of God known to us is Psychology. Thirdly, in our inquiries, we ask what our fellow men have thought, and said, and done, on this theatre of the earth ; and the answer to these inquiries we call history. Fourthly, we ask concerning the other acts of the Creator, known to us, beside the creation of human spirits ; we inquire concerning this universe of matter which He has made,—and trust that it is not irreverent to call the answer to our inquiries Natural History. Finally, our attention is directed to the Universe of Space and Time, in which the realm of matter floats, and to which our spirits are tied by our material bodies ; but the relation of which either to the finite or the Infinite Spirit, is beyond our grasp. And the truths of space and time which we are taught, we call mathematics.

In the following Curriculum, I lay out the plan of studies for an ideal course of liberal education ; laid out as within the reach of the majority of pupils, as I have known them in a long acquaintance with public

schools in our country. But it must be borne in mind by him who would examine and criticise that course of studies, that it has a unity from beginning to end ; and that the work of the later years will be impracticable for scholars who have not had the earlier training here prescribed.

CHAPTER XXIII.

A CURRICULUM.

I. Alphabet, or Sub-primary School.

For children five to eight years old.

1. *Mathematics.*—Building with little bricks, and blocks, playing with geometrical puzzles or tangrams, drawing geometrical figures; counting beans, and grouping them; keeping time in music, afterwards learning the Arabic figures.

2. *Natural History.*—Equilibrium, and breaking joints in their block buildings, gathering and naming stones, plants and insects; afterwards learning the names of their own limbs and bones; and the simplest facts of geography illustrated by a globe, rectified in the actual sunshine.

3. *History.*—Singing by rote, and afterwards by note; phonetic analysis of words, reading phonotype, and in the last year common print. Drawing from copies and natural objects. Careful subjection to the rules of the school, and incidental instruction.

4. *Psychology.*—Very little and purely incidental.

5. *Theology.*—Incidental, from presence at devotional exercises, &c.

II. Primary School.

For children from eight to eleven years old.

1. *Mathematics.*—Theorems of geometry as facts, without reasons. Drawing. The four simple rules of written arithmetic, in whole numbers and decimals, practised as an art, not studied as a science. Keeping time in music.

2. *Natural History.*—Incidental instruction on the sensible properties of body, degrees and kinds of hardness, elasticity, fluidity, etc. Afterwards on rust, combustion, soap making, fermentation, etc. Examination of minerals, plants and animals, and learning to recognize them. Geography from the globe.

3. *History.*—Visits to shops, farms, factories, &c. Draw, sing, and begin on the piano if convenient, at home. Reading and writing, both common hand and phonography; keeping in short-hand a brief diary; and writing in long hand letters to other children and little stories. Oral instruction in History of the United States.

4. *Psychology.*—As before.

5. *Theology.*—Incidental instruction directed chiefly to cultivation of a reverent and devout spirit, rather than to any theological opinions.

III. Grammar School.

For children from eleven to fourteen years old.

1. *Mathematics.*—Plane geometry. Mental and

written arithmetic, except evolution. Use of logarithms.

2. *Natural History.*—Astronomy in simple form. Physical geography, maps. Elementary mechanics. Incidental chemistry. Botany, zoology, anatomy.

3. *History.*—Oral accounts of inventions, and discoveries. Continue drawing and singing, introducing landscape, and part-singing. Commit to memory selections from the best poetry. Read French without grammar or dictionary. Towards the close, learn the parts of speech, and take the elements of grammar. Continue the History of the United States, and begin that of England and the Jews.

4 and 5. *Psychology and Theology.*—As before, the incidental instruction being based partly now upon the readings from the Bible.

IV. High School.

For scholars from fourteen to seventeen years old.

1. *Mathematics.*—Solid geometry, algebra, trigonometry and its applications. Brief review of arithmetic, with evolution, and practice in logarithms. Analytic geometry. For scholars of higher ability, the rudiments of calculus, and of quaternions, orally imparted.

2. *Natural History.*—Elements of acoustics, optics and thereotics. Physical geography. Geology. Elements of Chemistry, electricity and magnetism Physiology, botany and zoology.

3. *History.*—History of agriculture, manufactures, and commerce. Drawing and music. Continue to read French as before, and take up the study of Latin. Afterwards read German as you did the French, and take up the rudiments of Greek. Take successively histories of England and of Greece, and Rome. Constitution of the United States, with oral instruction on constitutional law.

4. *Psychology.*—Begin elements of intellectual philosophy, criticism, and ethics.

5. *Theology.*—The incidental instruction, from the Bible reading and from history, may become more full and explicit.

V. College.

For scholars from seventeen to twenty-one years old.

1. *Mathematics.*—(Only for those of mathematical ability).—Analytic geometry as affected by the calculus. Elements of more modern inventions, quaternions, stigmatics, kinematics, etc. Lectures on the methods of the mathematics.

2. *Natural History.*—(Reserved for those of special taste for these studies).—Analytical mechanics, applied to optics, thermotics, astronomy, etc., etc. Chemistry, botany, zoology, geology.

3. *History.*—Political economy, rhetoric. Writing on themes. Extemporaneous debate. Declamation of the student's own writing. Constitutional law. History of the Greeks, Romans, Jews and English. For

those of special tastes, Music and other arts; or languages, and philology.

4. *Psychology*.—Metaphysics, logic, aesthetics, ethics.

5. *Theology*.—Natural theology, evidences of Christianity.

THE END.

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